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Historical and Topographical Notes on Edom: With an Account of the First Excavations at Petra . . . George Horsfield and Agnes Conway 369

Danakil Traversed from South to North in 1928, Part II. . L. M. Nesbitt 391

Stone Polygons beside Loch Lomond . . Professor J. W. Gregory 415

The East Greenland Pack-Ice and the Significance of its Derived Shells V. E. Fuchs and W. F. Whittard 419

The British Arctic Air Route Expedition 426

The Fate of Andrée 428

Reviews The Monthly Record

Society Notices . . . . . i, iii

Contents v

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CONTENTS

HISTORICAL AND TOPOGRAPHICAL NOTES ON EDOM: WITH AN ACCOUNT OF THE FIRST EXCAVATIONS AT PETRA. By GEORGE HORSFIELD and AGNES CONWAY . . . 369

DANAKIL TRAVERSED FROM SOUTH TO NORTH IN 1928. Part II. By L. M. NESBITT 391

STONE POLYGONS BESIDE LOCH LOMOND. PROFESSOR J. W. GREGORY, LL.D., D.SC., F.R.S. 415

THE EAST GREENLAND PACK-ICE AND THE SIGNIFICANCE OF ITS DERIVED SHELLS. By V. E. FUCHS and W. F. WHITTARD 419

THE BRITISH ARCTIC AIR ROUTE EXPEDITION . . 426

THE FATE OF ANDRÉE 428

REVIEWS: Rambles in Devon. Through the Kennet and Avon Canal by Motor Boat. Suffolk. The *Annie Marble* in Germany. Rumania's New Economic Policy. Through Amanullah's Afghanistan: a Book of Travel. Ceylon. The Great Wall of China. Hebrewisms of West Africa. The Birds of Tropical West Africa. Go West—Go Wise! The Wilderness of Denali. Machu Picchu. Greenland: Its Nature, Inhabitants, and History. Deposition of the Sedimentary Rocks. Studies in Regional Consciousness and Environment. Die Erde und Ihr Wirtschaftsleben. Dynamische Länderkunde. The Voyages of Christopher Columbus. Crucial Maps in the Early Cartography and Place-Nomenclature of the Atlantic Coast of Canada 430

THE MONTHLY RECORD: Gilchrist Studentship. Glaciation in Western Ireland. Rock-Weathering in Corsica. North-Western Manchuria and the Reindeer Tungus. Drift-Bottle Experiments, Gulf of Mannar. Aerial Exploration in Northern Canada. The Sun and the Weather 444

MAPS:

To illustrate Mr. Horsfield and Miss Conway's paper:—
Sketch-map showing the location of Petra in Edom . . . 370
Sketch-map of Petra . . . . . *following* 448

To illustrate Mr. Nesbitt's paper:—
Diagram showing the points from which the second set of Mr. Nesbitt's sketches were taken, and their range 396
Route traverse from south to north through Danakil by L. M. Nesbitt, 1928 . . . . . *following* 448

To illustrate Mr. Fuchs and Dr. Whittard's paper:—
Diagram to illustrate route of *Heimland* through East Greenland pack-ice. 420

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The
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HISTORICAL AND TOPOGRAPHICAL NOTES ON EDOM: WITH AN ACCOUNT OF THE FIRST EXCAVATIONS AT PETRA: *A paper read in part at the Meeting of the Society on 16 June 1930 by Miss Conway*

GEORGE HORSFIELD AND AGNES CONWAY

PETRA has hitherto been studied as an isolated unit, a collection of monuments carved out of red Nubian sandstone cliffs, situated on the edge of Arabia; not as a product of human activity that had a being and a reason for being. In the past it was difficult of access and archaeological excavation on the site impossible, owing to the truculence of the local Arabs and the hesitation of the Government to issue a permit. Now the situation is eased and the Petra Exploration Fund Expedition, financed by the Honourable Henry Mond, M.P., was given a permit and worked without hindrance for two months in the spring of 1929, making the first excavations. The plan was to carry out a general preliminary exploration of the whole site, with the idea of following it up with a more fully equipped staff to undertake a large-scale excavation at a later date.

The scientific German expeditions of Brünnow and Dalman had been to Petra before the Great War to study what could be seen of the city above ground, and as a result of several short visits produced inventories, plans, and topographical maps of over one thousand rock-cut monuments, and studied the inscriptions. Sir Alexander Kennedy in 1924 published an invaluable aeroplane survey. But the rubbish dumps had not been dug and houses had not been distinguished from tombs. Dalman had made plans of a hundred places of cult. These conformed to no general known type and needed elucidation.

There are certain fixed points in our previous historical knowledge of the city. Petra is situated in the Biblical kingdom of Edom. At some date not precisely known, the Nabataeans made it their headquarters and later it became their capital city. Allusions in classical literature substantiate this; but the affinities and culture of this people were a mystery and where they came from unknown. Josephus tells us in the 'Wars of the Jews' that they were Arabs, which was the opinion of all ancient authors, and their personal names are Semitic, which fact is known from inscriptions recorded in Aramaic.

In 90 A.D. Trajan founded "Provincia Arabia" by incorporating the Decapo-

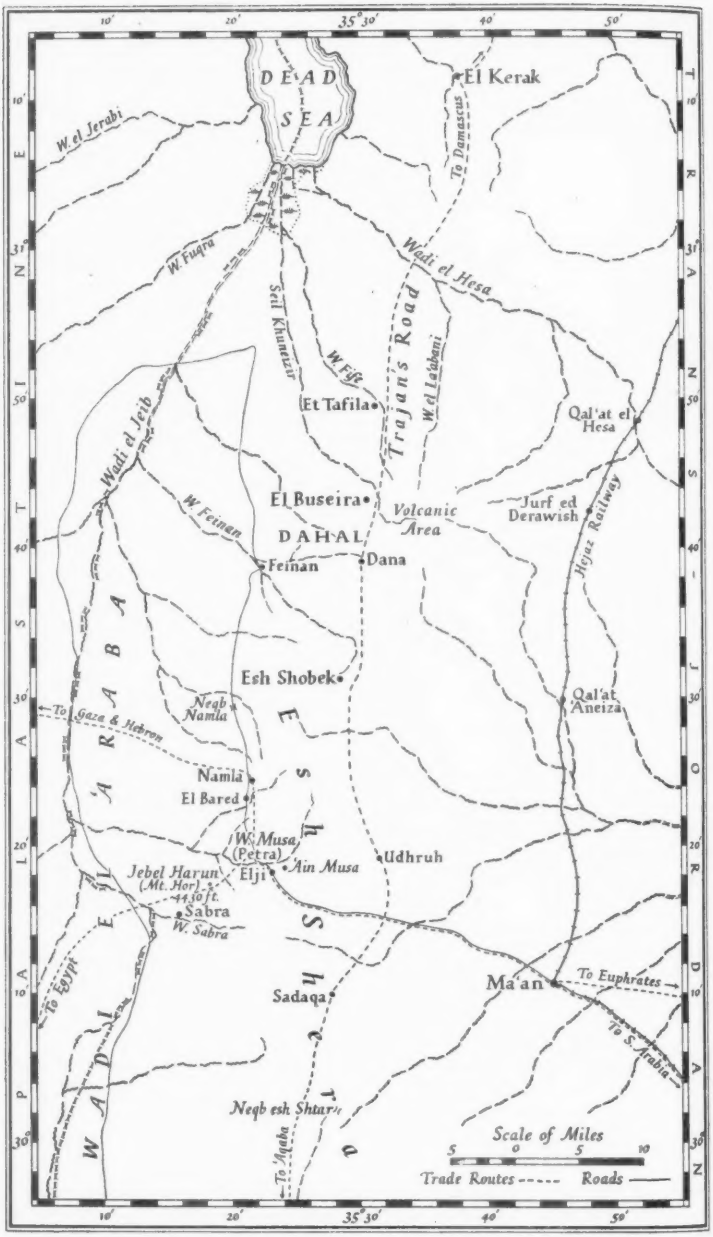


Fig. 1. The location of Petra in Edom

litan cities and Herod's old Tetrarchy of Peraea. "Provincia Arabia" appears on a Nerva-Trajan inscription found at Jerash, and in 106 A.D. Trajan added the remnant of the Nabataean kingdom and Petra, placing the capital city at Bostra. Petra was probably on the decline in the first century A.D., as Augustus' expedition to Arabia under Aelius Gallus no doubt disturbed, if not ended, the trade connections. The destruction of Adana, Arabia Eudaemon, by diverting the East India trade must have delayed and confused transport and delivery in favour of the rival Alexandria.

Ptolemy, the geographer, gives the latitude of Petra as 30° 20′; it is really 30° 19′. To realize the situation of Petra geographically it is necessary to examine a wide field. From the Lebanon in Syria to the Gulf of 'Aqaba runs the great rift of the Jordan Valley which forms the natural division between Eastern Arabia and the civilized and cultivated Mediterranean coast. Politically the north was always in the hands of a strong power, but the country south was more difficult to control, for it is cut by deep valleys running west which rise on the waterless desert fringe of the east; these in conjunction make difficult the transport and maintenance of armies and form strong natural defences.

At its southern end the east side of the rift rises to a height of 5000 feet above Petra, the Mount Seir of the Bible, the Jebel Shera of to-day. The northern limit of Edom was the Wadi el Hesa, which runs into the Wadi el 'Araba just south of the Dead Sea. To the north lies Moab, a high tableland whose southern face rises like a wall above the Wadi el Hesa.

The eastern limits of Edom present difficulties. It is necessary to consider the whole country as an economic unit. It is divided by nature into definite areas. The northern end is volcanic, from the Wadi el Hesa to a line drawn from Qal'at 'Aneiza, a station on the Hejaz Railway, to Jebel Dana, which overlooks the Wadi el 'Araba. South of this is a stony plain, which as it goes west rises and makes a rough pasture land. From the Ras en Neqb it falls to the Quweira Plain, a sandy desert which spreads to the east, and is broken by solitary rock masses (Pl. 1). On the west it is confined by a ridge of Nubian sandstone, which breaks out of the side of the Ras en Neqb, and divides the plain from the 'Araba. To the south the rock masses rise in high cliffs, which, narrowing to the western ridge, form the Wadi Yutm, then turn in a wide sweep to the sea, run down the coast of the gulf, and stand high as a background to the fishing village of 'Aqaba.

The edge of the 'Araba is defined by Trajan's Road which runs from 'Amman through El Kerak, Esh Shobek, Udhruh, Sadaqa, to 'Aqaba, and is marked by ruined military posts at intervals. The position of all the villages which lie below this line is determined by the springs which break out from under the limestone overlying the red Nubian sandstone. These are few in number and lie between Et Tafila and Esh Shobek, each surrounded by its irrigated gardens, olive groves, and fields of barley. From Jurf ed Derawish a road runs to Et Tafila: north of this to the Wadi el Hesa the land is broken and rough and forms a coarse pasture to which the Arabs come in spring to feed their flocks. The volcanic area is in parts covered with scoria: some of the valleys and hollows are roughly tilled. Above them rise the craters of extinct volcanoes. This high ground was not visited, but the Arabs say that water is led in channels underground—Roman work—and from openings in these channels they

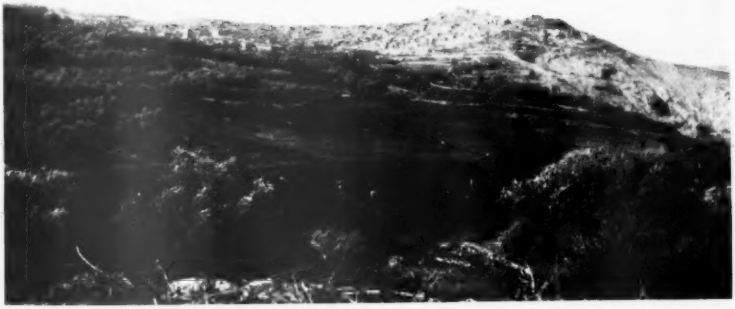
obtain water for themselves and their flocks. One of the main villages is Et Tafila, a large village on a mound, rising in tiers of windowless hovels (Pl. 2). On the top of the mound is a ruined mediaeval tower. This village is very picturesque, surrounded by cultivation and olive groves, at the head of the Wadi Fife. The water supply is plentiful and the village is the seat of the local governor, who is under the Mutaserrif of Kerak. Next to the south is El Buseira, identified with Bozrah, the Biblical capital of Edom, standing on an isolated mound nearly as high as the plain in the east. To the south of El Buseira and running down the slopes of the Wadi el 'Araba, as far as the Wadi Dana, is a charming stretch of broken country without villages and nearly waterless, with fine pastures in the spring, extensively wooded, and called Dahal. To reach it you pass down the left bank of the Wadi el Buseira on a track which gradually mounts, then past a rock mass into a wood of cypress and oak through which the track winds. The cypress trees are a distinct variety.

From the Sirhan, through El Buseira, and down through the country of Dahal, runs a track called by the local Arabs the Darb el 'Amalye. This, translated, means "the made road," of which there is not a sign; but on this track come sheep from the Wadi Sirhan, lean as greyhounds, to fatten on the Dahal pastures, before finding their way to market in Palestine. It is probably a very ancient route, and leads directly across the 'Araba to Hebron.

The next village is Dana, lying under the Jebel Dana, an extinct volcano which has blown up and exposes to the west a clean face. From here you look straight down to the Wadi el 'Araba, five hours away through a deep valley. A stream flows in the bottom and the sides are clothed with trees. In this valley ibex are sometimes shot by the Arabs. As it reaches the plain of the 'Araba, the stream is joined by the Wadi Feinan. On the delta between the mouths of these valleys lies Feinan (Pl. 3), identified with the Punon of the Bible (Numbers xxi, 4 and xxxiii, 42), where Moses invented the Brazen Serpent to heal the Israelites bitten by fiery serpents for a lapse into heathenism. Here is a mound covered with stones and lying around are fairly extensive slag heaps gained from smelting copper ore. To the west of the mound are the ruins of Byzantine churches and near them are remains of hearths and more slag heaps. Another wadi coming into the Feinan from the south is crossed by a ruined aqueduct, which carried water to give power to water mills; beyond these again are more slag heaps and ruins. The mound is nearest the Wadi Feinan: on its north side are the remains of a large tank and beyond is a plain running to the Wadi Dana, half a mile away, covered with rough circles and loose stones from Badawin encampments. To the east rises a porphoritic ridge; to the west a serrated edge of rock stands up from the 'Araba plain, whilst there looms in the distance the hazy outline of the hills of Southern Palestine. Both the wadis are dry, the water turning underground some distance before it reaches the plain. Reports of the Arabs would suggest that the copper came from Umm el 'Amamid, "the mother of columns," a cave farther south in the foothills, which has a small entrance and a roof supported by free standing columns. Hieroclitus, writing about 944 A.D.,* says that Feinan was formerly one of the principal cities of Edom, then only a village in the desert, where were copper works,

*"Fenon . . . quondam civitas principium Edom, nunc viculus in deserto ubi aeris metella (damnatorum supliciis effodiunter) inter civitatem Petram et Zoaram."

1. Quweira plain from Ras en Neqb, looking south



2. Et Tafila from the east

3. Feinan, looking east from the tell

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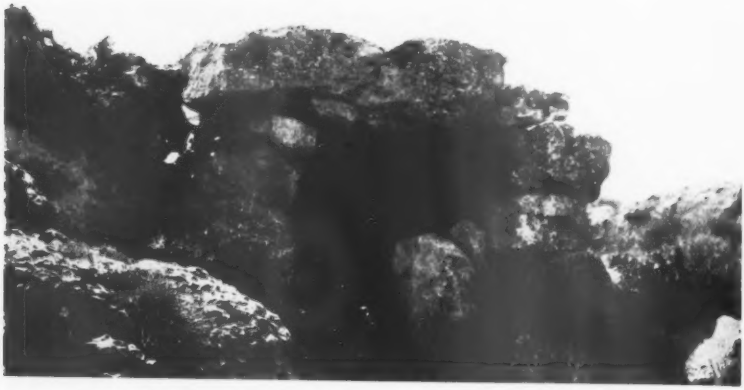


4. Megalithic dolmen between Dana and Esh Shobek

5. Megalithic circle, Petra, from the north-east

6. El Habis: Sela of the Bible, Sel of the Crusades

carried on by condemned criminals. From the Wadi Dana, Wadi el Jemel leads to the country of Dahal, from which in all probability the wood was drawn to work the furnaces for smelting the copper. To smelt copper a flux is necessary; for this iron is used. An Arab reported that iron exists in the foothills to the north of the Lisan on the Dead Sea, but this was not visited.

North of Feinan and south of the Dead Sea, under the foothills, lies an extensive area of cultivation, Abu Obeida, worked by the Badawin of the Wadi el 'Araba. South of the Qal'at 'Aneiza–Dana line lies the plain, whose surface is broken at intervals to the north by the extinct craters of volcanoes.

On the way to Esh Shobek, alongside the track, an hour and a half from Dana, are two springs situated within a short distance of one another. The one on the right is drinkable and has the remains of a pumping apparatus put in during the War; the other is medicinal, bitter, and undrinkable. Another hour's riding brings into view, on the right of the road, a megalithic monument, the mouth open, one side formed by a rock, the other built and roofed with slabs of stone, all rough and untooled (Pl. 4). Descending by a steep track, which winds through a tumbled mass of basaltic rocks, on some of which are Safaitic inscriptions, down the side of the Wadi esh Shobek, the fortress of the same name comes into view on the top of an isolated circular mound, with its walls and towers standing out against the sky. The view is lost on ascending the valley; cultivation gradually begins, then come trees and gardens lying on the sides of the watercourse. In the flank of the hills to the west, above these gardens, have been excavated caves, in connection with huts; forming a suburb which is indeed the main part of Esh Shobek, and about a mile below the fortress, which has only a few inhabitants. To the west the land is like Dahal, though less wooded and more cultivated. The oaks which formerly grew in hollows about Esh Shobek are gone: felled in the War for fuel for the railway. The remaining village is Elji, outside Petra, watered by 'Ain Musa, surrounded by gardens, trees, and barley fields, raised in narrow terraces around the hillsides.

Ma'an is an oasis in the desert, an eastern outpost, at present the termination of the Hejaz railway, the seat of a Mutaserrif, to whom belong Esh Shobek and 'Aqaba. Here are stationed sections of the Air Force and the Trans-Jordan Frontier Force, near the station. Around Udhruh, a Roman fortress, once of importance, is more cultivation belonging to the Badawin. Scattered fields are found along the Ras en Neqb and a few in the Quweira plain to the west, close in under the mountain. Above the Wadi Sabra to the south is more cultivation, and with that lying near the road between 'Ain Musa and 'Ain el Basta, a survey of the major part of the land cultivated in Edom at the present day is completed. East of the railway line is a desert covered with a light crop of herbage in spring, with occasional water-holes or wells. The Jafr depression east of Ma'an has water and there is an attempt at cultivation.

Edomite Arabs are divided into three categories: Fellaheen, those who have houses and live part of the year in tents; Arabs, who live wholly in tents, but have no camels; Badu, who live in tents and have camels. The cultivatable land can barely maintain the present inhabitants; the rainfall is precarious and indeed many emigrate from the villages to work in Palestine, going by way of Hebron to Jerusalem and other cities.

Ma'an has suffered an eclipse; maintenance of the railway, which since the Great War no longer operates to Medina, has ceased to provide a livelihood, the pilgrims now going by sea to Jidda. The Ma'ani, far from being turbulent as formerly, has become an eager searcher of work. The whole country is hungry and maintains itself on an illiberal ration of barley bread.

Genesis xxxvi, 15, gives us a list of the "dukes of the sons of Esau." Commentators vary as to the value and date of these, but it is suggested that the list is an insertion by a sixth-century B.C. editor, and is really a list of villages existing in Edom at that time. The only one which may be placed is Teman, *i.e.* Teima. From the description given above of economic conditions to-day it is unlikely that a larger population could ever have been supported than at present. The Wadi Sirhan was probably included within the Edomite territory. Indeed, to-day the Wadi Sirhan is an economic necessity to the existence of the Badawin for their winter sojourn with their flocks and herds of camels. This migration leads to endless feuds and raids, necessitating the maintenance of armed forces at Ma'an in an attempt to keep the peace, which is more often than not broken in interminable Ghazzu.

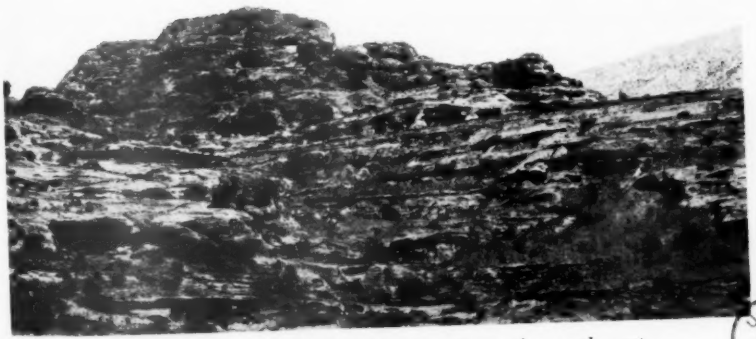
On the southern slope of Esh Shera, where the soft Nubian sandstone breaks out of the mountain side, about the centre of the district between the Wadi el Hesa and 'Aqaba, and between the Hejaz railway and the Wadi el 'Araba, lies Petra. It is in a basin surrounded by cliffs, into which the water from the eastern mountain slopes drains, by way of Wadi Musa and the Siq, to find an outlet through its continuation, the Siyagh, on its way to the 'Araba. The Petra basin with its surrounding cliffs must be pictured as a shelf between the high desert plateau of Ma'an, 1500 feet above, and the Wadi el 'Araba, 2500 feet beneath and below sea-level. The Wadi Musa, flowing between towering cliffs in a narrow channel to the precipice above the 'Araba, is dispersed in spray before it reaches the rift valley below. The highest mountain of this ridge is Mount Hor, 4280 feet, the Horeb of the Old Testament, crowned by the white-domed tomb-mosque, the reputed burial place of Aaron, the forbidden and most revered shrine in Trans-Jordan.

The basin of Petra, with its two perennial springs, was the one natural easily protected refuge of man, where he could maintain life with security in a vast desert area. The central field, about 2 miles long, sloping gently from north to south, is bounded on the east and west by mountain ranges, cut by ravines and riddled with natural caves which were easily turned into dwellings. The Nabataean and Roman cities covered this area, enclosed by walls on the north and south. The water from 'Ain Musa, which flows down the wadi of the same name, was diverted at the mouth of the Siq, the principal entrance to Petra, through a tunnel, so as to leave the road free, and permit the floor of the Siq to be paved for the easy passage of the inhabitants and the trains of camels which frequented this great emporium.

The first inhabitants were troglodites, mousterian man, the earliest type of "homo sapiens." Some 19,000 years ago they inhabited the natural caves, leaving behind them flint implements which are occasionally found on the site. These caves, after being lived in successively by Edomites, Nabataeans, Romans, Byzantine Christians, Crusaders, and Arabs, are still to-day the refuge of a primitive people without property, laws, or religion; waifs and

7. El Biyara, the Nabataean citadel

8. Ruined wall on summit of El Biyara



9. Rock-cut houses of El Mu'eisra from the south-east

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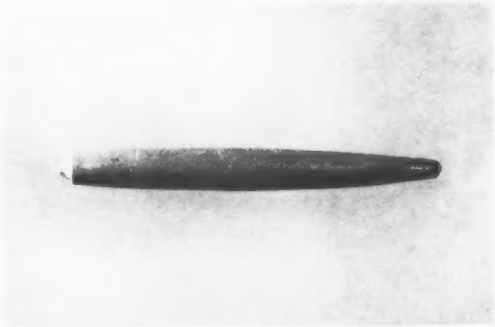
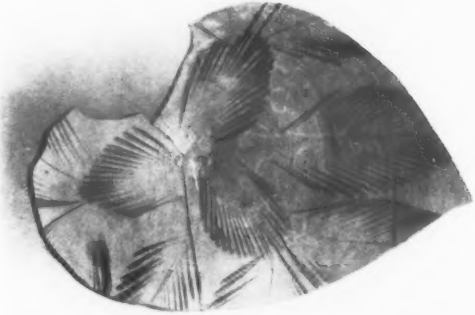


10. Stone pencil, probably for writing cuneiform

11. Terra-cotta head of horse: actual size

12. Parthian horse in terra-cotta: half size



13. Sherd of painted bowl: palm leaf design

strays who have drifted into holes and corners to escape the notice and insults of their more highly organized Arab neighbours, too weak and poor to merit much attention. About ten families of these Bdul, some with two children and one goat, move from cave to cave in accordance with the season, and to-day are the only permanent dwellers in Petra. Others go to Gaza to seek employment.

The Edomites were the earliest historical inhabitants, perhaps, like the Israelites, a nomadic people, or, more likely, as to-day, a mixture of Fellaheen, Arab, and Badu. The first mention of Edomites is on an Egyptian inscription, when they applied at Pelusium for a passage over the frontier in the reign of

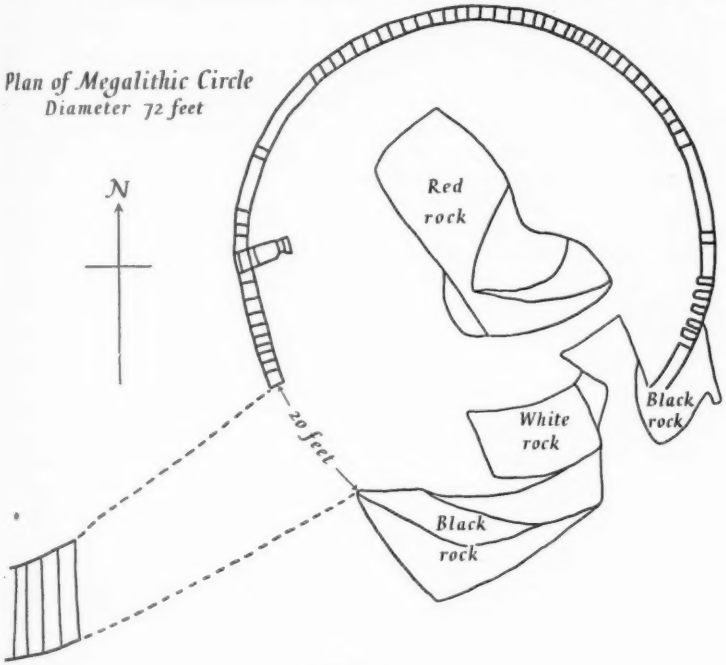


Fig. 2.

Rameses II for themselves and their flocks, to go to a pasturage in the Faiyum. In the reign of Rameses III a punitive expedition was sent against the people of Seir of the tribes of Shasu, and Edom figures at Medinet Habu as one of the nations subdued, on a relief depicted with typical costume and physical features.

No excavations having been made in Edom, no objects or monuments were known; but the Mond Expedition found a megalithic circle, probably of the Edomite period (Fig. 2 and Pl. 5). It is 72 feet in diameter and stands outside the north wall of the later-built city on a rock whose highest point it encloses. The exterior of the wall was plastered with lime and the joints

12. Parthian horse in terra-cotta: half size *13. Sherd of painted bowl: palm leaf design*

between the stones filled in and wedged with small ones. It has the appearance of typical Mediterranean bronze age masonry, not uncommon in other parts of Trans-Jordan, in watch towers and foundations of strong places. This was a retaining wall, a single stone thick, showing no sign of tooling, the inside filled to the peak of the rock with red sand. Beyond this again on the face of the fall of the rock is cut a flight of steps. From it is obtained a view of the whole site of the city. This may have been a primitive sanctuary of the period before the revelation of Moses, when Edomites and Israelites followed the same religious tradition; a natural rock altar, enclosed by a wall because it was sacred.

The book of Judges vi, 8, supplies a story which interprets, in a measure, the use of such a primitive sanctuary. Gideon, sorely troubled by the misfortunes of Israel, ravaged from the east to the sea coast at Gaza by the Midianites, was visited by an angelic visitor, who told him his mission was to deliver the Israelites. Gideon, doubting if indeed he spoke with an angel, asked for a sign and said, "Depart not hence, I pray thee, until I come unto thee, and bring forth my present and set it before thee." Then with busy eastern hospitality, Gideon made ready a kid, and unleavened cakes of flour. Putting the flesh in a basket and the broth in a pot, just as to-day when a meal is prepared in a tent of hair, he presented it before the visitor. The angel then touched the flesh and bread cakes with his staff and fire came forth out of the rock and consumed them. This was the sign that Gideon had demanded. And when he perceived he was an angel of the Lord he built there an altar.

This is one of the cases in which the Bible enshrines the memory of an earlier stage in ritual development passing on to a later one. The preparation of the food was done in his village, particularly the act of slaughter, so that the actual shedding of blood was no part of the ritual. It was set out on a natural rock table and miraculously consumed with fire by the agency of the mysterious visitor. Gideon had no idea of making a burnt offering. Yahveh burnt the flesh miraculously and unexpectedly upon the rock, thus instituting the ritual of a burnt sacrifice, which requires an altar and which Gideon then set up.

In Joshua, chapter iv, we are told how the people of Israel were ordered to pick up twelve stones out of the Jordan, as a memorial of their crossing, which they set up in Gilgal on the east border of Jericho. The word "Gilgal" is considered by scholars to mean a megalithic stone circle, something which was older than the Israelites and which they used as a framework for their Memorial Stones. No such "Gilgal" has yet been found in Palestine or Trans-Jordan. Perhaps the Petra circle is a "Gilgal," the first to be found, making, with the natural rock-table within it, the earliest type of sanctuary in Arabia.

The Hebrews reckoned the Edomites kin by blood and the Bible names Esau as the father of the tribe. Edom was situated on the boundary between the Hittite and Egyptian Empires, suffering no doubt the same tribulations as befell other neighbouring Semitic peoples, of which the Bible gives so graphic an account in the history of Israel and Judah. As we have seen, she was exploited first by Egypt, probably for the sake of her copper mines at Feinan and another at Sabra, a suburb of Petra, discovered by the Mond Expedition (Pl. 24). It is also known that copper and turquoise exist in the mountains south of Petra,

though no workings have been found there. These must have been known, coveted, and worked from a remote antiquity.

Petra, signifying rock in Greek, seems to be mentioned at least once in the Old Testament, under the name Sela, meaning rock in Hebrew. In II Kings xiv, 7, we read how King Amaziah of Israel "slew of Edom in the Valley of Salt ten thousand, and took Sela by war." The Arab geographer Yakut, in the twelfth century A.D., mentions a place called Sel as being in Wadi Musa, the name by which the Arabs to-day speak of Petra. One of the crusaders' castles at Petra was called Sela, one of the last three castles in the Outre-Jordain fief to surrender to Salah ed Din. The entrance to this castle is on the south-eastern end of the rock of El Habis, with the ruins of walls, doorways, cisterns, and staircases. In one of the walls are arrow shoots. This hill is an isolated rock stronghold and may well have been called Sela in the time of Amaziah (Pl. 6). In the days when the water supply came from two springs, which lie in close proximity to the rock, it would have been the natural fortress for a sparse population of nomads using Petra as a refuge.

Apart from the Biblical record, Edom first appears upon the page of history in the Assyrian Chronicles. Adad-Nirari in 802 B.C. forced tribute from all the western Semitic kingdoms. Then came a series of rebellions, followed by submission. Ai-Rammu, King of Edom, appears at Lachish in Southern Palestine in 702 B.C. to make his peace with the Assyrian Sennacherib. Egyptian intrigues with these bordering tribes were no doubt responsible for their misfortunes in attempting to use them in face of the encroaching menace of Assyria. At last Nebuchadnezzar's conquest of Palestine and the overthrow of the Judaean Kingdom, with its ensuing transfer *en masse* of the population to Babylon, left the south empty. The increasing pressure on the eastern desert frontier pushed back the Edomites, until eventually they are found in South Palestine in the district which later became Idumea.

Of the seventeen years of the reign of Nabonidus, the last king of Babylon (555–539 B.C.), many were spent fighting the Amurru and the Edomites, perhaps from his headquarters at Teima, which he had captured, and whose inhabitants he had driven out or slaughtered. Here he lived in an unexplained retirement far from the Government of Babylon. This was carried on by his son Belshazzar, implying a confidential relationship between father and son rare in Eastern sovereigns, which casts an interesting light on the character of Belshazzar. This arrangement came to an end with the conquest of Babylon by Cyrus the Persian, and the surrender of Nabonidus. If we accept the identification of Teman with the Teima of the westland of Nabonidus, then an explanation is afforded of the cause of that wave from the desert, which swept in and swamped, with the fleeing hordes of Teima, the westland of Edom.

In the first chapter of the book of Job is the story of a raid which took place in open daylight in the fall of the year, "for the oxen were ploughing and the donkeys feeding beside them and the Sabaeans fell upon them and took them away." It is considered by scholars that the book of Job was written in the fifth century B.C. by some one resident in Northern Edom, perhaps in the neighbourhood of Tafila, which is supposed to be the Biblical Uz and north of Petra. The account of the raid is a commonplace, and illustrates the uncertainty

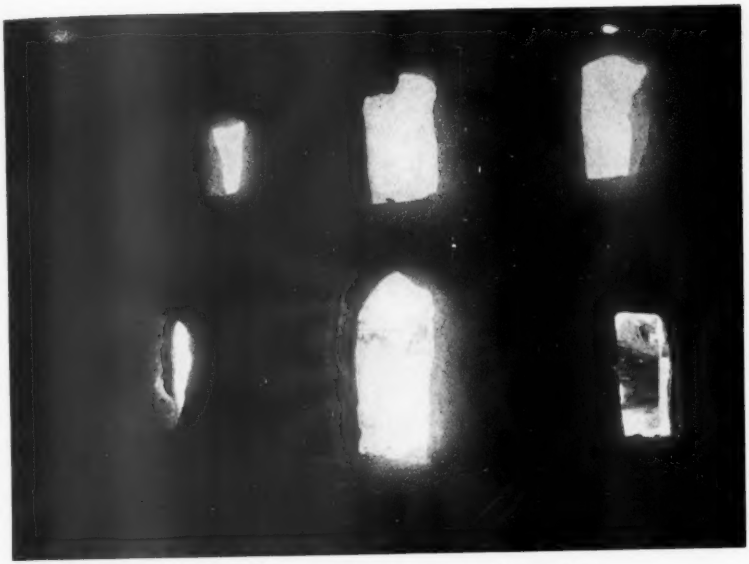
under which the inhabitants have always lived. It is interesting, for it is just what might happen to-day.

The book of the Prophet Obadiah, dating also from about the middle of the fifth century B.C., reviles the Edomites thus: "Behold I have made thee small among the nations, thou art greatly despised: the pride of thine heart hath deceived thee, O thou that dwelleth in the clefts of the rock whose habitation is high." He goes on to compare Edom to a vineyard which the grape gatherers have stripped bare, contrary to the usual custom of leaving some gleaning grapes. The Prophet Malachi, of about the same date, says: "I hated Edom and made his mountain desolate and gave his inheritance to the jackals of the wilderness." These two accounts suggest the entry of a new people into Petra, "built in the clefts of the rock, whose habitation is high" and the expulsion of the old inhabitants from the mountain of Esau.

Who these jackals of the wilderness were is a question that has never received an accepted answer. The Nabaioth of the Old Testament, from among whom Esau took a wife, are not now confounded with the Nabataeans. There was an Aramaean tribe of Nabatu, described on inscriptions of Tiglath-Pileser III, the Pul of the Bible, as living on the banks of the Southern Euphrates in the eighth century B.C. At Teima, where Nabonidus resided, and in the Wadi Sirhan, there are inscriptions of the sixth and fifth centuries B.C. in Aramaic, as well as remains of a culture with a distinct character. The Wadi Sirhan, a famous roadway, camping ground, and chain of water-holes, is a series of linked depressions, extending from Jauf on the south-east north to Azraq. To-day the eastern frontier of Trans-Jordan lies to the west of it. The great caravan route that crossed the desert from the Persian Gulf *via* Petra found at Teima a halfway house for revictualling and refreshment. Is it not possible that Job may have confounded his raiders with the Sabaeans, when really they were Nabatu, driven from the possession of the eastern grazing grounds and watering-places by the activities of Nabonidus, and forced on to the frontier of cultivated lands which lie above and on the western facing slopes of the Wadi el 'Araba?

That the Edomites were still in possession of Edom, or at least a part, in the reign of Xerxes I (486 B.C.) we know from the correspondence found at Nippur by the Pennsylvania Museum Expedition, as the commercial house to which it belonged numbered Edom among its customers. By 312 B.C. the Nabataeans were definitely established in Petra and possibly were the successors of the Edomites in their whole territory. They were strong enough to repulse Athenaeus, a general of Alexander the Great, who attacked them with 4000 infantry and 600 cavalry. This is the first definite mention of Petra in history apart from the Biblical Sela, and by this time it must have been something of a city and no mere refuge of nomads from the desert.

Our source for this campaign is Diodorus Siculus, who lived in the first century B.C. but probably used earlier and lost authorities. He described what he thought to be the Nabataean mode of life in Petra in the fourth century B.C. Their main difficulty then as always was the storage of a water supply, as they only had two springs in the basin of Petra. He relates that they filled caves with water vessels and made cisterns flush with the ground which no one could see. When at a great fair two days' journey away (perhaps at Ma'an) they left their



14. Interior of rock-cut house: height 30 feet

15. Tiers of houses in the Siyagh

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16. Wadi Musa entering the Siyagh, looking east

17. The Dushara, El Bared, looking west

18. Wahabi caravan crossing the southern section of Petra

possessions, their old men, women, and children on a rock excessively strong and unwalled, which had only one way of ascent, made by hand.

The only rock in Petra that answers to this description is El Biyara, which dominates the city to the south (see folding sketch-map and Pl. 7): the name means "the cisterns." It looms up behind El Habis, a dwarf by comparison, on which stands the crusaders' castle of Sela. Its frowning crags are impregnable, without track or foothold. There is only one way up made by hand, an inclined plane, which in its existing worn state takes two hours to climb. At the bottom it was defended by a gate, of which there are some remains. The top is flat, open, and of considerable extent, and in it are excavated seven "cisterns sunk in convenient places" as described by Diodorus. A narrow neck, which a large stone would cover, widening out as it descends in the shape of a pear, is about 4 metres deep, to the top of the fallen stones with which each cistern is now partly filled. A surrounding catchment area drains the rainwater into them, and their like are found nowhere else in Petra. Scattered in all directions are the ruins of walls and foundations (Pl. 8), with many rough sherds of pottery.

Strabo, in his geography, writing at the beginning of the Christian era, states that Petra had no walls. Excavation contradicts him, as a wall was found running from El Biyara, under El Habis, and continuing above the Wadi Farasa to the opposite cliff of Zibb 'Atuf. On the surface of the rock inside the wall were found fragments of black Athenian pottery of the fourth century B.C., Rhodian wine jar handles of about 300 B.C., and a terra-cotta head of a horse, 1½ inches long, in style and perhaps in date of a type that approximates closely to those from the pediments of the Parthenon (Pl. 11). Gaza, which lay on the route from Petra to the Mediterranean, was a client city of Athens, in trade relationship with Petra, so it is easy to understand the presence of this pottery.

After the conquest of the Babylonian King Nabonidus by the Persian Cyrus, the empire of his successors gave relative peace to the orient for two hundred years. This permitted the development and organization of commerce on roads that ran from Sardis to Susa, from Susa to the Indus, and from Memphis to Babylon, frequented by travellers of all nations, establishing an active commerical traffic and acting as intermediary between east and west. Aramaic, written in cuneiform, became the official and commercial language in the eastern provinces of the Empire. Five stone pencils, seemingly for writing cuneiform, were dug up at Petra (Pl. 10), but no cuneiform tablets have yet been found.

The evidence of the commercial correspondence of the Jewish trading house of Nippur, to which previous reference has been made, with Chaldaeans, Medes, Aramaeans, Edomites, and Sabaeans, together with the South Arabian inscriptions and the black stone of Berlin from Egypt, are ample testimony of the universality, activity, and freedom of commerce within the Persian Empire at this period.

The Sabaeans occupied what to-day is the Yemen, and their capital was Mariaba: of them, except for inscriptions, little is known. In their country grew the trees from which frankincense was gathered, a commodity of great value and importance in the ancient world, and of which vast quantities were pro-

duced and consumed. Every prayer and public or private ceremony demanded it; all altars smoked with it. The altar of Marduk at Babylon alone consumed a thousand talents' worth a year. Besides producing this valuable commercial article, they held in their hands the transit trade with the East Indies, and their Port of Arabia Eudaemon, the modern Aden, was the port of transhipment. The commodities imported were gold, silver, precious stones, spices, perfumes, and woods of great value, which passed on by caravan or sea to the Mediterranean *via* Petra. Later Alexandria shared in it, and the policy of the Ptolemies to get more of this trade was the principle that guided them in their political relations with the Nabataeans.

In the fourth century B.C. Petra began to hold the key position to the trade routes between east and west, to which she owed her wealth. This was partly due to her strategic position as a centre on which trade routes converged, and partly to the patronage of the early Ptolemies, to whose interest it was to attract into their neighbourhood the trade from the East Indies, of which they did not control the land route, but in which they thus indirectly shared the advantage. The employment of the sea route was to the disadvantage of Petra, as the goods could be shipped direct to an Egyptian port on the Red Sea. Thence probably arose the piratical practices of the Nabataeans, for which they were notorious towards the end of the first century B.C., in an attempt to destroy the commerce with Egypt, and divert it to their own port of Leuke Come. The exact date when this port rose to prominence is not known. They were sufficiently powerful at sea to destroy the navy of Cleopatra in the Red Sea.

After the death of Alexander the Great in 323 B.C. his rival generals founded the Seleucid Syrian Empire and the regime in Egypt in which the Ptolemies reigned as Pharaohs. The King of the South and the King of the North, as the Book of Daniel, written in the second century B.C., calls them, were continually at war. "The highways were unoccupied, and the travellers walked through byeways." The highway was the road on the Palestine plain on the coast. The byeway was the road from the Red Sea through Petra, which being difficult and practically waterless was safe from military operations. The Nabataean kingdom was an independent buffer state, holding the key of the routes to South Arabia in Petra, getting every commercial advantage from the struggles between the warring north and south. It was a blend of the culture of both and a resort of merchants and travellers from the Mediterranean and Eastern worlds.

Syria fell to Pompey in 69 B.C., and Augustus captured Egypt. The expedition to Arabia under Aelius Gallus was in 25–24 B.C., which shows the interest Augustus took in trying to get advantage from and control the land route. It is thought that at the end of this campaign he destroyed Arabia Eudaemon, Aden, which must have struck a great blow at Petra's commerce. That Petra was rich and powerful and Hellenized after 129 B.C. we know from a decretal of Priene, in honour of one Moschion. It is known that King Aretas III was proud to surname himself Philhellene, as also did the Parthian kings. His kingdom in 85 B.C. included Damascus and Syria, and reached the banks of the Euphrates. This was the period of its greatest expansion and the conquest of Pompey the beginning of its decline.

Strabo, writing at the beginning of the Christian era, describes the caravans

19. Symbol of Dushara on El Khubtha

20. Sanctuary of Dushara, Zibb ʿAtuf, Petra

21. Grooves in altar-pedestal of Dushara, Zibb ʿAtuf

22. Rock-cut lion on way to Zibb ʿAtuf

23. Burials in quick-lime below symbols of Dushara, El Muʿeisra

24. Copper smelting station, Sabra

from the Nabataean port of Leuke Come on the Red Sea as being so large as to look like armies on the march, in spite of a duty of 25 per cent. levied by the Romans at the port of entry in an endeavour to force all the trade to go *via* Egypt. The Song of Songs, which dates from about 200 B.C., gives an interesting description of a caravan coming over the desert. We read, "Who is this that cometh up out of the wilderness like pillars of smoke, perfumed with myrrh and frankincense, with all the powders of the merchant? Behold it is the litter of Solomon." In another chapter we find a list of scents and spices. Henna and spikenard plants, spikenard and saffron, calamus and cinnamon, with all the trees of frankincense, myrrh, and aloes and all the chief spices. The sight of a caravan coming over the desert in a cloud of dust is familiar. The takht er-Rum, gaily painted and adorned, borne on two camels decorated with little bells, mirrors, and ostrich feathers, escorted by footmen on either hand, to help over rough places: each camel's slow footfall, sinking together with strange solemnity, bearing the leader of the caravan.

The scent on the still dust-laden air, the suk of any eastern city will supply: Damascus, Cairo, or Istamboul. Cinnamon is a product of the East Indies. The word itself, "Kinnamon," is Aramaic. May we not think that these particular songs were composed and sung by a Jew of Petra, familiar with the trade of the Sabaeans and first sung there?

Petra's history is spread over a thousand years, bridging the transition from the old world of the east, which fell before Alexander the Great, to the new world of the west, which saw the rise of Rome and Christianity. She was a parasite, set in a howling wilderness, drawing all into her net, proud, rich, and prosperous, manufacturing little or nothing, confined to her cleft in the rocks and operating not at all, except in her immediate neighbourhood, the arts she had borrowed from her neighbours. In no other places near at hand have been found, so far, monuments of a similar type, except a cistern or two in the Quweira plain. Her inhabitants may be imagined as dwelling in wealth and security in her rocks, only issuing forth with an armed caravan on business or pleasure. Perhaps the memory of her wealth and security survives subconsciously in the Arabian Nights which, when the story teller wants to depict a marvel of wealth, security, and mystery, place it in a cave in an unknown fastness such as Petra is.

Turning now to the consideration of the site of the city and its boundaries, Strabo supplies us with the information that owing to the state of peace in which the Nabataeans lived, their cities had no walls. In the side of the wadi below El Biyara is a long upright chase in the wall of the rock; on the opposite side a rock projects which has been cut into a square to form the foundation of a tower. In the wadi bed nothing remains, but connecting the two together no doubt in the past was a wall, arched and blocked in some fashion for entrance and exit to the southern route to Egypt. From the tower a wall runs up the steep slope to El Habis, the summit being fortified as previously described, its sides carved into rooms at many levels, the fronts of which, being built, have long since disappeared and are now but heaps of tumbled stones, lying at its foot. Starting, the Nabataean and the Byzantine wall take the same course, the distinction between them being the repairs made at a later date with the drums of Hellenistic columns. East of El Habis they separate, the Nabataean wall

following the course of the Wadi Farasa and the Byzantine, nearly in parallel line, running along the crest of the hill to the rock Ez Zantur, which rises in the southern section, nearly cutting it in two; it once was crowned with a large building, of which little remains. The mounds called El Katute are heaps of rubbish, which have been thrown over and on to the Nabataean wall, and slid down to the wadi bed. From Zantur the walls run on to the east, the Nabataean still following the Farasa, and the Byzantine lying on top of the slope, until they both strike the cliff of Zibb 'Atuf about 250 metres apart. The Nabataean wall has occasional bastions and towers at sharp turns or at the top of descending ground, where it cuts across a depression.

Between these two walls at the Habis end a cutting was made into the side of the tell. The surface was covered with potsherds and there were the remains of Christian graves; flagstone boxes, which the rains had partly washed away. Gravestones marked with crosses but without inscriptions give the identification. On the bed rock below the accumulated sand and stones was found the pottery of the fourth century B.C. previously described. From the surface came Roman and Christian lamps and pieces of terra sigillata, and intermediately Rhodian wine-jar handles of the second century B.C. Whatever buildings had previously occupied the site had been grubbed up to the foundations, except a house, over which the Byzantine wall had been built.

So much for the south wall. Turning north it is more difficult to define the line of the Nabataean wall, but the Byzantine is quite easily followed. The Nabataean wall runs from a point north of the Florentinus Tomb and the other is about 200 metres south. Between the walls, in an extensive rubbish heap, are graves similar in type to those found under El Habis and also Christian. The Nabataean wall goes straight from the cliff to the Wadi Mataha, running a little way down the left bank. It then crosses to follow the right bank upstream to a ridge, on the highest part of which is the Edomite circle; it then turns to the high bank of the Turkmaniye Wadi, which it follows downstream to 'Arqub el Hishe, a small fortified post, where the Byzantine wall, after following a fairly direct line across the site of the city, joins in. This Nabataean wall is difficult to find and its exact course is uncertain, but a line of wall is traceable outside the Byzantine wall, probably having been demolished to build it: this latter has many fragments of Hellenistic buildings built into it. The walls, having become one, follow the descending left bank of the Turkmaniye Wadi to Qabr Jumei'an, until the wall is lost about 300 metres above the junction of the wadis and the mouth of the Siyagh. How it ended is not visible, owing to the silting up at this point, which is the junction of three wadis; probably anything that did formerly exist has long been washed away.

Examination brought to light no gates and few towers or bastions, to strengthen or support the walls. In structure they are slight, averaging about 2 metres thick, built of long stones of no great height, set dry: therefore they were little more than a curtain wall, not built to withstand a siege with engines, but to ward off a surprise raid which might find its way in through the intricacies of the mountains. It appears clear that the traffic entrances to the city could only have been by the wadis. The Siq was the main entrance, and had at its mouth an arch, which sprang at a considerable height from its walls: a source of surprise to earlier visitors, but fallen towards the end of the

nineteenth century. Its position is marked by niches and pilasters carved into the rock face. The Thughra and the Turkmaniye wadis were the entrances from the south and north respectively. A more thorough examination by excavation may demolish this theory, but it is borne out by the present use of the city by caravans, which enter and leave precisely at these points, for the simple reason that there exist no other ways of getting in or out.

On 12 April 1929 we saw a Wahabi caravan coming through Petra from Hayil on its way to Egypt, driving camels to market (Pl. 18). There were about three hundred of them, all in good condition. The Wahabis were riding horses, and had been twenty days on the way. At Ma'an the Trans-Jordan Government took toll of them at ten piastres a head. From Ma'an they made a long detour to the north, passing above Petra along the southern slope of Jebel Shera to the rock-hewn suburb of El Bared, where they halted for the night. The reason they gave for the detour was the comparative flatness of the ground. They entered Petra by the Wadi Turkimanye, crossed the city at Zibb Far'on, and went out to the south under El Biyara, on the road to Egypt *via* Sinai, where they hoped to arrive in five days.

A much larger caravan of about one thousand camels came through on May 15, on their way to be sold at Lydda, in Palestine. They entered Petra, like Cook's tourists, *via* Elji and the Siq. We met them there on our way back to Ma'an with our baggage, and after a two-hours' struggle got through without accident, except for a few dropped loads.

The shorter passage to the sea-coast from El Bared, by the Namala Pass, the ancient trade route to Gaza, is not favoured, as the going is rough, with practically no food or water. We went down it for four hours. The track leads through a wide wadi at first, but when it reaches the porphoritic region it winds in and out amongst great fallen porphyry blocks. We found the remains of a camel, and there were fresh droppings on the track; so that it is used, but not very much, for small numbers who want to get through quickly.

It is possible that this suburb of El Bared, one and a half hour's ride to the north of Petra, may have been the ancient sorting-place for caravans. There is a small rock-cut town in a cleft, but outside that, between the limestone outcrops, there are large flat open spaces, green and fertile even to-day, in its uninhabited, unirrigated condition, while Petra is a desert. There are ruins of huge cisterns, and foundations of what look like enormous camel khans. No systematic exploration of El Bared has yet been made. The fact that the Wahabi caravan from Hayil spent its last night there proves that it was the final station on the way to Petra, on the southern and eastern trade routes, as well as the first station out of Petra on the northern trade route. This caravan gave us an opportune first-hand demonstration of ancient trade routes.

The plan of the site of the city is divided by wadis into four quarters, three inside the walls and the En Nasara quarter lying outside to the north. The wadis were bridged, and the streets paved with flagstones, but there are no visible remains of colonnades.

The southern section of the city is cut across by Ez Zantur and access from one part to the other was only possible on the slope above Wadi Musa. Parts of the city area have been cultivated and the loose surface stones gathered into rude walls to divide it off into fields by later inhabitants. Where the surface

sand has been scoured away are remains of foundations, and the lower parts of buildings are visible in the southern section. In the northern section they are more numerous, and it is possible to make out the plans of considerable structures. This seems to be the part that was occupied to the end.

Outside the walls in the Siyagh, which was no doubt included in the enclosed city, and on the Mu'eisra ridge to the north-west, are two residential quarters consisting of houses carved into the rock (Pl. 9), the fronts and possibly extensions being added in masonry: these have entirely disappeared as such, and are represented by scattered fallen piles of stones. The Siyagh (the continuation of Wadi Musa, when it passes into its bed after crossing the side of the city) is peculiarly adapted for the beginnings of a settlement, as it is easily defended and in close proximity with the two springs. The wadi is deep and narrow at both ends (Pl. 16), which facilitates its defence, and is close to the citadels of El Habis and El Biyara previously described.

Both the Siyagh and the Mu'eisra have streets cut through the face and on the surface of the rock, with rows of houses, communicating staircases, and cisterns (Pl. 15). Rising from the bed of the wadi, many of the lower rooms are deep in silt, and it seems as though the Siyagh was at this early period deeper, and free from the sand and boulders which the growth of oleanders now holds in position. The rows of houses are yawning holes, weathered and decayed, but with indications of ornamental niches and clamp holes in their carefully squared inside walls (Pl. 14). Stucco and remains of painting occur in some, but in none is enough spared to reconstruct a scheme of decoration.

The chambers themselves have been altered, rebuilt, and put to different uses, but still manifest their origin, though a tomb or a cistern has been thrust in among them. Even in their worn ruined condition, in spite of quarrying, which has partly cut them away, the impression is given of a thriving busy quarter, which in no way now expresses its original appearance when inhabited. Owing to the entire disappearance of the house fronts, which once marked the face of the rock, and hid the excavated rooms, these now yawn and gape prominently.

Again tombs and graves have been contrived in all directions. The flat surfaces have tomb shafts sunk in them. Houses have been reused for burials, and tombs with typical Nabataean façades have been cut, wherever the rock is sufficiently high, singly or in groups. On the Mu'eisra ridge unrifled tombs were found, which on comparison with the pottery index obtained from the sections cut into the rubbish dumps were of the third century B.C. The walled city at this date already occupied its present large area. An unrifled tomb group shows complete specimens of pots, which are the same as that from the rock surface under the dump of the fourth century B.C. Another tomb group belongs to the middle level, dating after 150 B.C. Unless the living and dead were intermingled, it would seem that this old part of the city was abandoned and used as a cemetery in the third century B.C. If this hypothesis is accepted, then the houses, streets, and stairs must be of the fourth century B.C. or earlier. The Siyagh unfortunately gave no chronological information, all the tombs having been stripped bare: the comparison with the dwellings on the Mu'eisra ridge shows a close relationship in plan, execution, and in such details as survive. The conclusion is that these areas are the ancient beginnings of the city:

the nucleus of the original settlement being in the Siyagh, in a "cleft in the rock," as the Bible so aptly puts it.

Only ceaseless labour, long and continued, spread over a long period of time, could have contrived and managed the intricate system of canals, pipe-ways, and cisterns, by which the rainwater, which fell on the surrounding mountains, was collected, run off, and stored. Without this, the place is uninhabitable. It must have been the first work of public utility to which the founders of the city and those who guided its development turned their hands. Their skill and ingenuity ensured the prosperity of the city and made possible the congregation of vast numbers of people, and the artistic development, which surprises travellers even in these days, by comparison with the howling wilderness by which it is approached and surrounded on all sides.

Knowledge of Nabataean culture may be gleaned by references in many ancient classical authors. In the matter of their religion they are explicit. The Nabataeans worshipped the Sun-god, under the name of Dushara, symbolized under the form of a black stone. The most famous black stone in Arabia is that built into the Ka'aba at Mecca, the symbol of the ancient local god, whose cult was reformed and preserved by Muhammad. The kissing of the black stone set in the Ka'aba is still the culminating ritual act of the Moslem pilgrim to Mecca. In the third century the Roman Emperor Elagabalus, hereditary priest of the Sun-god at Emesa, who caused grave scandal in Rome by walking backwards in front of its symbol, a conical black stone, when carried in procession, was himself worshipped in Arabia under the symbol of a black stone. A description of the sacred image of Dushara, kept in the central sanctuary at Petra, has survived in the work of Suidas. It was a black stone, four-sided but unshaped by tools, 4 feet high and 2 feet square (*cf.* Pl. 19), resting on a base of beaten gold. The blood of victims was poured out before it and the shrine itself was adorned with gold and many votive offerings.

The Great High Place of Petra on Zibb 'Atuf, a sanctuary whose significance has been widely discussed with no agreement, may be identified as a sanctuary of this image and its worship (Pl. 20). It stands on the top of the mountain, linked by a steep processional stairway with the two finest rock-cut chambers in Petra, forming part of what once was probably a royal palace. One is a hall, with a decoration of engaged fluted columns, adjoining the only house façade in Petra with detached columns. This is a definite type of classical house, found at Delos and Pompeii, and called Rhodian by Vitruvius. Above it, reached by a flight of steps, is a large cistern and the ruins of a barrel-vaulted room. These buildings form a definite isolated group blocking the end of the valley.

Ascending at the other end by stairs to the High Place, an altar is passed cut out of the rock; opposite is a lion of heroic size in high relief (Pl. 22), and from the rock above his head, is cut a channel from which the water pours when it rains. Aretas, the name of four Petraean kings, is derived from the Arabic "Haritha," meaning lion. Carved out of the rock between the palace and the sanctuary, it may be the badge of Aretas, in Assyrian legend the symbol of the Sun-god, identifying him in person and worship with the cult for which the High Place above was designed.

The sacred black stone has long disappeared, but cuttings on the altar

throne pedestal of Zibb 'Atuf (Pl. 21) indicate that once something stood on it, which may well have been the four-square unwrought symbol of the god. On this sanctuary four processional ways converge, for the convenience of assistants at the sacrifice, oblation, and worship.

To the left of the altar, carved on the top of the adjoining rock, is a circular basin, with a rebated rim, with a channel running down to the front of the rock and delivering into a hole, which was filled with sand. Above is an oblong deep cutting, with a drain evidently for containing a liquid. The circular basin may have been for the blood oblation, but as nothing is known of the ritual it is difficult to assign a use for it, except that Suidas says blood was used. Excavation of the sand-filled hole brought to light a considerable quantity of sherds of fine red eggshell pottery, in the shape of saucers. Some of the fragments were painted in purple, but none of the sherds formed a complete whole. The painted patterns show a large variety of designs, of considerable originality and artistic merit, distinctly oriental in character, and not under any classical influence. Some of the forms resemble the unpublished faïence pots from Nippur in the Pennsylvania Museum, Philadelphia, U.S.A., brought back by an expedition sent out in 1882, and in fabric are as fine as the thin yellow unglazed Achaemenid pottery found at Ur this year.

A similar pottery, but slightly coarser, was found in the city dump of rubbish and in comparison with other objects found with it, dates from 150 B.C. to 100 A.D. All over the site fragments may be picked up (Pl. 13), so it was of common use and not made especially for the service of the god; but that found nearby the altar no doubt was ritually used, perhaps for the offering of blood.

Symbols of Dushara are carved on the rocks in all parts of Petra, singly and in groups, which has led to some confusion and the invention of places of cult, when the signification can but have been that a pious Nabataean in his devotion to Dushara caused his divine image to be cut to express it, in his house, in his shop, his work place, or over his grave. Similarly are found religious symbols in India, or crosses in Christian countries.

At El Bared one of a different form was found standing at the top of a flight of steps in the Siq and dominating it, though somewhat obscured in these days by a tree which has grown in a crack in the rock behind it. The steps are about thirty in number and the rock on which the symbol stands about 6 metres high (Pl. 17). The two stones represent Allat, the great mother goddess of Arabia, and her son or consort Dushara. In the rear are long channels cut in the surface of the rock, so that the two symbols are isolated, and enclosed on the sides by the cliff walls. They face east, and when the sun sinks in the west they stand outlined against the glow, a natural solar sanctuary and seemingly of great antiquity.

The worship of the black stone of Dushara still lingers at Petra, his ancient sanctuary. In the shrine of the Tomb of Aaron on the top of Mount Hor, fixed in the wall opposite the prayer niche, at the height of a man's head, is a stone of greenish black, polished by the kisses of his many devotees. At his side, represented by a triangle of red sandstone, stands Allat the great mother.

The burial customs of the Nabataeans were explored by clearing shaft graves in various places, but the most interesting was found on the Mu'eisra ridge. The Tomb is entered from a court, and on the right is a small room;

beyond the court is a small chamber, open in front. From its appearance and plan it may have been originally a house, but the roof to the court and the side room have gone. A wall originally shut in the opening to the rear chamber, which is raised on a step, projecting in the centre, and suggests that a door was once here. On the back wall were three Dushara symbols in niches, with small scooped-out shelves between to contain lamps (Pl. 23). Another Dushara is carved on the right wall. There were seven graves, two being shallow and the remainder shafts 2 metres deep. Three lay under the Dushara symbols in front of the rear wall. Two contained nothing but fragments of bone in red sand, but the centre one was filled to the top with lime concrete. This was removed, and then came cover stones: under these more red sand with which the grave was filled. Scraping it away, a hard white mass was disclosed surrounded by sand, which extended the length of the grave. It was shapeless and uneven in contour, but had a definite outline. No objects were found. Breaking into the white mass there was disclosed a black powder with which it was filled. Its greatest depth was about 6 inches. The white substance was quicklime, in which a corpse had been enveloped, producing a perfect incineration, every bone being consumed. Under it was more red sand and nothing else. One shallow grave held the bones of an adult and of a child, but they were buried in the ordinary way. None of the other graves contained any objects. The chamber gave no indication of its date, but the tool marks on the walls were similar to those found in other monuments. Other tombs in the same area contained remains of cremated corpses, but this was the only one in which this peculiar method was employed, which seems to be unique in the ancient world.

The prophet Amos, writing about the eighth century B.C., cursed Moab because he burned the bones of the King of Edom into lime. Perhaps this method was employed with the idea of a preliminary purification, or with the notion of escaping in some way the purifying fires of purgatory, a method which is employed by some pious Jews with this intention even in our days. From the Dushara symbols carved at the head of the Tomb, it may be that here were graves of a priestly caste employed in the service of the god. Whether the recipient of this peculiar cremation hoped to find alleviation and escape from the pains and penalties of his sins by expiating them on his dead flesh we do not know.

Previously have been discussed the walls and the elaborate regulation of the water supply, one being the complement of the other; for without the water supply the walls would have been unnecessary, no large population being able to support existence in this arid place without it. From the objects found near the wall, its date must be either the fourth or third century B.C., so it may be assumed that Petra at this date was rich, flourishing, and well populated. Her decline is evidenced on the site by the large rubbish heaps on the south-east side of the city, between Ez Zantur and Zibb 'Atuf, and between the Nabataean and Byzantine walls, of the first century A.D.; a monument, perhaps, of the success of the policy of Augustus in gradually diverting her trade to the benefit of the imperial patrimony, Egypt, and so encompassing Petra's economic ruin.

To the earlier period of her history may be assigned the smaller pylon crow-stepped monumental tombs, which later developed in scale and in detail to those of vast size with which the surrounding cliffs are crowded: a type which

was used to the end of the first century A.D., as those at Madain Salih witness by their dated inscriptions, as well as that designed by Queen Shaquilat, the mother of Rabel II, the last King of Petra, for her brother Onesu. The one seen on the left of the valley above the entrance of the Siq, with its obelisks on top, answers well the description of the Tomb of the Maccabees at Modin in Palestine, of the second century B.C., as given by Josephus. Others with similar detail exist, among which is the Tomb of Florentinus, with its Latin inscription. The inscription does not agree with the architecture, unless it is a witness of an archaeological copyist, perpetrating at a later date an earlier type of design. More probably it is an intrusion of the second century A.D., so much feared by owners of tombs, who have inscribed on those of Madain Salih threats and curses, with promises of fines and punishments, for any daring intruder who should interfere with their testamentary behests and the succession of their descendants.

It is not possible to assign dates to any particular monuments, but the conclusion may be drawn that none of the more important ones date later than the first century A.D., whilst the majority are of an earlier period, examples of Hellenistic architecture of a type that has been developed to suit the material from which they are wrought. Of a like detail no others exist, so far as present knowledge goes. When compared with the second century A.D. monuments at Jerash, they have no likeness to them. These are crude and in detail uninteresting. Most of the columns at Jerash have pedestals and an entasis, that is, a gradually swelling and diminishing of the outlines of the columns, whereas at Petra both are unknown. The carving at Petra, particularly on the Khaznah, is full of invention and fantasy: at Jerash it is of a dull sameness. It is not suggested that the artists of Petra were native born, they were imported. A population such as dwelt at Petra would be desirous of expressing their wealth and culture architecturally. Syria and Alexandria were no doubt full, as are New York or London to-day, of artists and architects anxious for work. Commercial intercourse between these cities brought the ambition to turn their ideas into stone, to gratify the pride of their patrons.

Hellenistic architecture is lost, or so confounded with Roman, which is a development from it, that at present it is almost impossible to distinguish or date any Hellenistic monument. Hadrian visited Petra, and is said to have built or restored public buildings, but to-day nothing is recognizable. Further research will add to our knowledge of Petra's place in history, date her monuments, and solve a problem that haunts all who know and have studied her history and her art.

DISCUSSION

Before the paper the PRESIDENT (Colonel Sir CHARLES CLOSE) said: To-night we were to listen to a paper on Petra and Edom by Mr. Horsfield. Mr. Horsfield is detained out in the East because he is carrying on another excavation; but Miss Conway has most kindly consented to read the paper he has sent in the form of notes, which have had to be somewhat abbreviated because our time is to-night somewhat limited.

The first substantial exploration of Edom was carried out, for the Palestine Exploration Fund, in 1870, by Professor Palmer who, as you know, was after-

wards killed in the Sinai Peninsula. Then there was a survey of the Wadi el 'Araba by Professor Hull and Captain Kitchener in 1883, also carried out for the Palestine Exploration Fund. Then, just before the war, there was a survey of the Neqb (which touches, though it does not coincide with, the area we are about to discuss) by Captain S. F. Newcombe, Mr. Woolley, and Mr. Lawrence; so that there is a good deal of exploration to be accounted for in that region, a good deal that we ought to read up.

Meanwhile, I may say that Miss Conway was with Mr. Horsfield in Petra. Much has been discovered which was previously unknown; a new light has been thrown on the history of that most interesting place. In order that you may picture exactly where it is, I may say that those who have the map mentally before them will know that Petra is about halfway between the north of the Gulf of 'Aqaba and the south of the Dead Sea. With these few remarks I ask Miss Conway to kindly commence the lecture.

Miss Conway then read part of the paper printed above, and a discussion followed.

Dr. E. W. G. MASTERMAN: I am sure that, at this late hour, I should do poor service if I kept you more than two or three minutes, but I am glad to have the opportunity of thanking the speaker for the extraordinarily interesting lecture we have had. My only claim to be here is that I, like perhaps many of the audience, have had the privilege of paying a flying visit to Petra and, as with all who have been there, the fascination of the place has remained with me: the most fascinating place I have ever seen. When after that visit I, many years ago, heard a lecture by Sir Alexander Kennedy on the subject and saw some of his wonderful photographs, I felt, as many others must have done, that although we could admire the beauty of the many-coloured rocks which are perhaps the least important part of the subject but one on which much stress is laid, and while we may be fascinated by the various carvings, yet we do not know much about the history of Petra. I remember Sir Alexander Kennedy did in his lecture refer to the possibility of Babylonian influence in some of the symbols seen there.

This evening I think we all feel that Mr. Horsfield and Miss Conway and Dr. Canaan, whom I know very well, have in their work gone a real step farther and thrown quite fresh light on the subject. If I have any special reason for speaking, it would be to back up Miss Conway's claim that the work which has begun so hopefully should be carried on, because I feel we have a great deal of new information. Some of you know the Great High Place, and this new theory about it is most fascinating. Then the Nabataeans are a race about which we seem to know almost nothing. For the first time, as far as I know, we have seen some most beautiful pottery found there, and we are told that there are great dumps of rubbish waiting for the excavator to turn out the treasures that lie buried therein. Miss Conway has taken the opportunity of telling you this because she wants to help Mr. Horsfield in doing some more work, and I only hope that she has so excited your imagination and raised your expectations that you will continue to follow the work both in its literature and also in a practical way.

Mr. LOUIS C. G. CLARKE: Though the part of the world about which we have heard is distant from any part of the world in which I have worked, I feel I must congratulate Miss Conway on the excellent paper which has been compiled. I am in charge at Cambridge of the most interesting articles which you have seen on the screen. I think Mr. Henry Mond has started an excellent work in financing the expedition, and I hope he will continue. Mr. Mond comes of a family well known for such beneficence. His uncle, Mr. Robert Mond, has financed many very important expeditions in Egypt. I feel that the excavations at Petra may

throw so much light on a part of the world we know little about that I can only hope there will be a second excavation and that Miss Conway will be on the spot to carry it out under the command of Mr. Horsfield.

The PRESIDENT: In the few words that I wish to add I must first say that we are all most indebted to Mr. Henry Mond for having made the expedition possible. He has undoubtedly opened a new chapter in our knowledge of Petra; far more is known as a result of this expedition than was known before. We are also greatly obliged to Mr. Horsfield and Miss Conway and their companions for the remarkable work they did in a short space of time. But looking at the pictures shown on the screen it is easy to realize that years of work remain. I was pleased that Mr. Horsfield and Miss Conway discussed the history as well as the geography of the place. I suppose we all agree that it is not possible to read or understand history without knowing a great deal about geography. If there is a dull book in this world, it is a history book without maps. It is obvious that it is impossible to understand the history of Petra unless we understand its geography. Well, we are much indebted to all those who have made this evening possible, and we thank Miss Conway particularly for having stepped into the breach when Mr. Horsfield was unable to come and read the lecture. She has given us a clear idea of the remarkable piece of work which she and her companions did in Petra. In your name and in the name of the Society I thank her.

DANAKIL TRAVERSED FROM SOUTH TO NORTH IN 1928: *The second part, continued from page 315, of the paper by*

L. M. NESBITT

THE second day of our stay near Gallifaghe on the Awash, one of the envoys of the Sultan of Aussa returned to his master with our papers. The other, an elderly man who had been secretary to this Sultan's famous father, Yaio, remained behind, as we realized, to keep a watch on us. He showed great surprise at our reading a map under his eyes, and pointing out the names of places in various directions. We told him that all white men could get such papers for a trivial sum in their own country and that his country was well known to them already.

During the morning a bullock was killed, a beast of great size as they go in this region, and with a beautiful black-and-white spotted hide. The greater part of the meat was cut up to dry. Four goats were also killed, and the refuse scattered round the camp over a couple of acres attracted many beasts of prey. All night dogs, hyenas, and jackals fought over the spoil.

The Sultan's envoy had told us that durra and a camel load of milk were being sent to us, and during the late evening three camels arrived with butter and durra and a request from the Sultan for us to move nearer to him as he would move towards us. So next morning, May 15, we left at 9 a.m., and at 12.30 p.m. reached the Awash bank again at Aroberifaghe. This day's run was as hot as could be imagined, first over desert ground and later between volcanic hills. No relief could be found in drinking and resting: it was like a furnace. We had five men sick, and one camel had to be abandoned. Later the animal was reported dead from a swollen heart, and the tail, freshly cut, was exhibited as a proof to us.

The Sultan did not come and see us that day as it was a day of rest for his family observed since the time of his father Yaio, who seems to have been a big chief. Even the son, Dejaz Muhammad Yaio, the present Sultan, commands great repute. He is the biggest chief in Danakil and superior to many Abyssinian Rasses both in rank and on account of his large province Aussa, which is mostly barren but for a zone where the Awash, losing itself in the ground before it bifurcates and forms a number of lakelets, affords moisture to the soil. This is a limited fertile area but is of great importance in this region of barren scorched desert. It forms an oasis, a sort of halfway house, and accounts for the only caravan route, and that of little importance, which crosses Danakil, connecting Tajura or Assab *via* Aussa with the plateau markets near Mofa, Erifible, Batie, etc. The route here crosses Danakil along the line of least resistance, which I have taken as the dividing line between the two main sections of the great Danakil rectangle, Southern and Northern Danakil. No other trade routes exist except on the extreme southern border of Southern Danakil, the former Zecla–Antotto route, now superseded by the Jibuti–Addis Ababa railway, and on the extreme northern border of Northern Danakil the little-used route from Meder *via* Dallol and Aduwa to Makale.

Late that evening a camel arrived laden with milk and butter, six big *girbas* (goat-skin containers), and another camel with *ingera* (a typical bread of the

plateau Abyssinians, here regarded as a delicacy) for us, and other breads for our men. These were all presents from the Sultan, who is very rich and "full of everything," as the camel men said. The old envoy then wrote a letter for us to him thanking him for his gifts.

We loafed all next day at Aroberifaghe and watched the crocodiles and fishes and birds. I killed a large crocodile which had eaten a girl, and skinned the brute with Rosina and Abulker, taking three hours over the job. In the evening another camel load of milk and bread arrived, and we had beautiful fish for supper. During these two days here we had such an abundance of food that though we wanted to force on our men whatever was left after the distribution, they all refused it, being more than loaded up already with stores of dry meat and fresh supplies. Their greed at last seemed satisfied.

All next day we waited for the Sultan, who had sent word that he would come in the morning. Later he sent another message excusing himself and saying that he would come two days later. This man has only been once to Addis Ababa since his father's death and has since never moved from Aussa for fear that somebody else might put himself in his place. He possesses all that grows and lives here, cattle and people included, and anything he leaves in the hands of his subjects is his just the same. He has many spies over his territory, the old envoy told me. He thus owns thousands of cows, and large herds of camels, but they really have no great value here, as there is no trade and the people do not seek a market, but are averse even to improving or tilling much of their lands for fear of exposing their value to the greed of foreigners. They only cultivate durra and that for the bare necessary food. And they are primitive and savage and idiotically inquisitive. They stop and look at you with open mouth and gaping eyes, or laugh and laugh at everything you do.

During the night the roaring of hippopotami kept us all awake. Our camp was right on the water's edge, on a vertical bank some 20 feet high. The forest here was thick, with huge mimosas and vines and other trees, and below dense undergrowth, with small clearings only showing in patches and these invariably covered, owing to the shade and moisture, with good grass teeming with wild life. The night before the noise of the hyenas and their laughter, delivered by hundreds at a short range, had been quite startling. The crack of the branches as they roamed about on our side of the river and on the opposite bank, the roar of leopards and the blowing of the hippopotami and their heavy tread, breaking underfoot and abreast all they found, and spelling terror to the lesser animals, all added to the weird effect. By day innumerable birds and monkeys enlivened the dense forest. The monkeys, when they went down to the river to drink, were very timid and suspicious. The families of little ones were very pretty to watch. The river here teemed with fish and there were always many crocodiles floating on it and basking on its banks in the heat of the day. We saw several large python also in the tall grass near the river, and we shot several wild boars.

Next day, May 19, the old envoy, who had gone the night before to see the Sultan, returned in the afternoon, and told us that his master was even then coming to us and that his approach would be announced by the trumpet blasts which accompanied his progress. But couriers were also on the road to carry the news, and these reached us before the sounds of his trumpets. Thereupon

we moved out and went, the three of us, with the interpreter, two men, and the old envoy, towards the approaching cortège. We stopped at a short distance from our camp under a shady tree and gradually the bugles were distinguishable coming nearer and nearer. Soon after war cries were also dimly heard, and these in their turn grew in shrillness and intensity. But the climax came with the sudden appearance between the scattered trees of a troop of cavalry, approaching us in apparent disorder and fury, their steeds excited, with lances flourished in the air, rifle-shots, sticks, bells tinkling and a general yelling and gesticulating of arms, legs, bodies, and thongs, flying and flapping about, and making such a confusion and wild effect as I had never seen before.

The leader of this troop approached and salaamed from his rearing horse; then the whole squadron did likewise, turning and returning, wheeling their horses about at each run's end, whilst their yelling and gestures grew wilder all the time like a wheel gradually increasing in speed, till the whole troop seemed in a frantic state of excitement.

Meanwhile the advance guard of the Sultan had arrived at the double. This was a group of some hundred men armed with rifles, who once in sight of us started to yell as vigorously as their mounted companions. But now the cavalry disappeared and went to meet the main part of the cortège. In a few minutes this arrived, whilst the advance guard had kept us busy watching their repeated charges back and forward from end to end of the aforesaid clearing, a straight run of some 250 yards. It was an impressive sight, this mob of armed men in flowing chammas, all yelling together a war cry of theirs and in the distance a brilliant red parasol overtopping this moving mass of soldiery. This parasol was borne over the head of the Sultan, who soon became discernible, mounting a white horse. He approached, riding in front of the soldiery now drawn up in a line stretching from end to end of the clearing, followed by many an officer and favourite. He stopped a little farther than the end of this line under a tree where a folding chair, upholstered in red, and four men holding rifles in red flannel bags were waiting for him.

The cavalry, after a final flourish which covered the clearing a few times in all directions, now retired and disappeared, but activities of a strange nature were kept up by two groups of about ten men each. These, starting from the opposite ends of the line of soldiery, went in Indian file from one end to another, crossing their march in the centre, singing and yelling continually. And all the while irregular blasts from two trumpets enlivened the show.

We were under the same tree watching all this odd military display when several lesser chiefs came to greet us, then a squad of personal servants of the Sultan seeking refreshment, coffee, etc., for their august chief, which they obtained from our kitchen where they were dispatched. We ourselves remained under the tree exchanging salutations with the ministers of the Sultan. Soon four camel loads of provisions, milk and bread, came in sight, crossed the clearing and were presented to us, as had been the custom every day since we reached here. Then twelve head of cattle and a flock of sheep and goats arrived, enough to stock a farm.

The old envoy was meanwhile going backwards and forwards between us and the Sultan, exchanging many greetings. The Sultan sent word to us that he was now going to rest and later would speak with us; but it became late, and

as we returned to our tent near by a message came saying that he would spend the night here and to-morrow would meet us and spend the whole day with us. This seemed to us too great a favour. To spend almost two days on a visit appeared to us an exorbitant waste of his time as his residence, Furzi, was only three hours from here and the matter might have been settled in half a day. But he wished this, so we thanked him. The army all this time was taking swims by relays in the river, where they seemed to have no fear of the crocodiles, filling gourds and examining our camp at a respectful distance. Most of these people had never seen whites before.

All next day we were not able to see the Sultan, because he was busy with a tribunal, three of his men having been killed near here a few days ago. The criminals, to save themselves from very likely reprisals, flew to his camp, but did not find the clemency they may have hoped for, as they were executed.

During the morning, after an hour's illness, Rosina's remaining mule died. The poor beast, though with a vicious habit of kicking every one, was a good one for work and endurance. While we were attending to it some chammas and sandals were stolen from our Abyssinian servants. These Danakils are thieves of the first order. The night before they stole a bag of bread from our enclosure and even the envoy and other petty chiefs now attached to us had to keep their belongings close to our tents to avoid losing them through the rapacity of their own countrymen.

In the evening I shot marabout, of which there were hundreds near here now, and falcons and eagles and all sorts of birds of prey. They had been attracted by the spoils of the cattle which had been killed. The usual camel loads of bread and milk also arrived. So the buckets and gourds full of the previous supply had to be emptied by throwing the milk and butter they contained into the river or anywhere to make room for the fresher supplies. Likewise whole quarters of bullocks were thrown to waste. But these gifts were all signs of the greatness of the chief.

Next morning, May 21, we received a message saying that the Sultan was waiting to meet us. So we went, Pastori, Rosina, and I, followed by our interpreter, the envoy, and the messenger. We walked about twenty minutes till, hidden amongst the trees, we saw at last a group of soldiers, the red ensigns and other quiet movements indicating the presence of the Sultan. The messenger went ahead to announce our arrival, but he returned immediately to bring us forward. The soldiers drew to a sort of "attention," the half a dozen ministers around the Sultan bowed, and the Sultan rose from his folding chair and greeted us repeatedly in subdued tones as is the custom of the country. Next he dismissed all his men, ministers included, even the faithful eunuch, the elderly man near him, and with our interpreter we were left alone with him under a shady mimosa.

The Sultan is a man of some thirty to thirty-two years of age, small, bright looking, European featured, but very dark, just as a Danakil is, *i.e.* not of the dull black of a slave, but a shiny coffee hue. He wears a small beard, has good eyes, and a kindly smile: in a word, a pleasing personality. He asked after our health and the trip, if the road was good, and if all was good, and other courteous questions repeated and answered endlessly, as is the custom here.

We in our turn, through our interpreter, the only native present, kept up this soft-toned volley which went on for at least three-quarters of an hour. The Sultan said he would give us a good guide to take us north, with the "silver baton," the singular emblem which gives the carrier thereof, when giving an order to the Sultan's subjects, the authority of the Sultan himself. We thanked him very cordially, for we knew that the silver baton had been reputed unobtainable by white men. Indeed Giulietti, the Italian explorer in 1881, after waiting in vain for it for several months outside the Aussa Sultanate, had ventured on without it and had later met a cruel death when he and his party of fourteen Italians were massacred a little farther north in the Biru Sultanate. Next came inquiries as to our wants, and after some more idle prattle Rosina and I bade the Sultan farewell and left, Pastori staying to discuss with the officials the details of our needs, *i.e.* camels, provisions, and goat skins (we were promised twenty-five large skins as a present from the Sultan). This business was transacted with some ministers and the Sultan. I wanted to photograph the Sultan, but after kind excuses he said he could not do what his father had never done. So we parted.

In the evening Pastori returned very disgusted, as the Sultan wanted 100 Thalaris Maria Theresa (about £10) apiece for the ten camels we needed, which is double what they are worth here. In the end we had to pay this sum for them but were allowed to pick from the group of forty that the Sultan had brought down. The money was counted by the Sultan's men and seven camels delivered to us. They were very good beasts, fat, with enormous hunches and marked with the star, the brand of the Sultan's family. The Sultan promised us a gift of eight cows and twenty goats, but we refused them and only took two goats. To smooth over any bad feeling roused by the wranglings over camels he also promised three bags of durra. As we needed this very badly we accepted his offer and sent him our three empty bags, which were very large indeed. In the evening he departed and his bugles were heard for some time after he had moved off.

In the early afternoon the envoy and his son left us after touching farewells. We were now practically unwatched after our virtual imprisonment since our arrival at Aroberifaghe, so I seized the opportunity to explore the surrounding region. On the plea of going shooting, Pastori and I left the camp, and, unaccompanied, travelled for a few hours downstream keeping close to the Awash bank. On the opposite side of the river and in the section of country between the two arms of the Awash there were unmistakable signs of irrigation. The dykes with which the watercourses were embanked showed places where they had been cut to allow the water to flow on to the immense fields, and then built up again at the end of the irrigating period. The country was rolling at first, then merged into an endless plain stretching away in the distance and treeless except for a slight fringe near the river. On our side, in contrast, there was very thick forest.

It was good to see the open flat lands bearing everywhere the marks of husbandry, although of the most primitive pastoral type. Cattle, horses, camels, and people moving in the distance dotted the green pastures. We would have liked to have pushed farther downstream, but it was getting late and we had to return. We were very glad however to have seen something of the much-famed

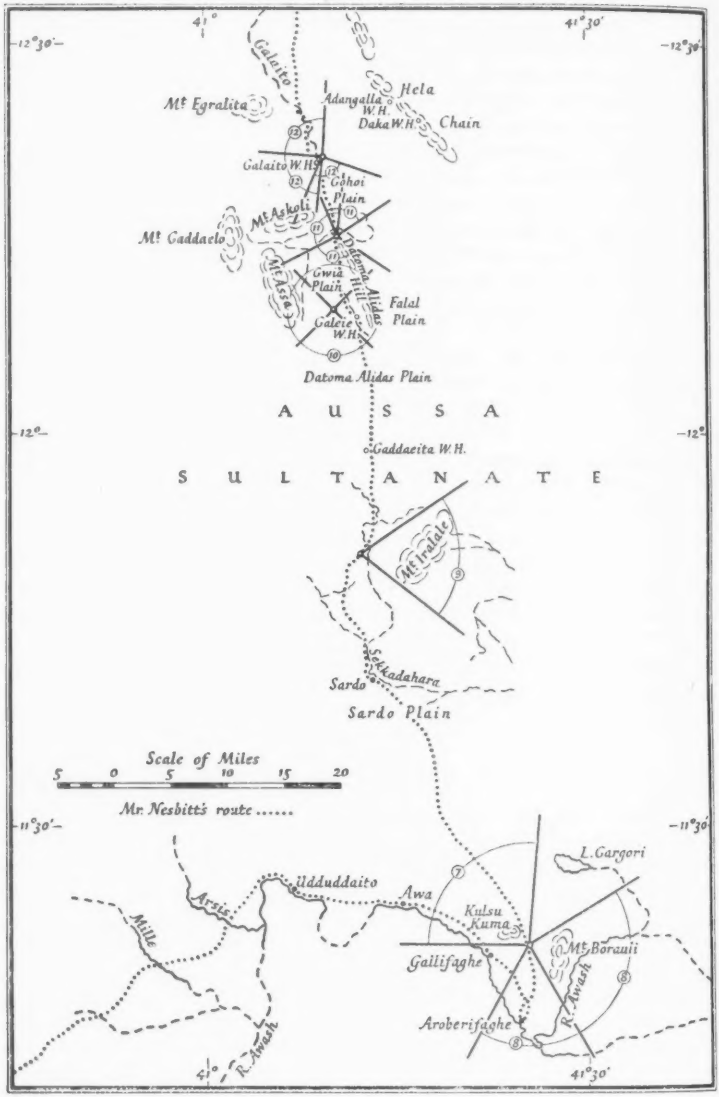


Diagram showing the points from which the second set of Mr. Nesbitt's sketches were made, and their range

fertile plains of Aussa, the only redeeming spot in Danakil and the only one where any sort of agriculture (durra growing) is practised.

On our way back we tried to make straight for camp through the forest, cutting off the curves on the river. Progress was difficult however owing to the density of the trees and bushes. The forest was full of game, and in the rare more open patches snakes hissed in the tall grass, which here grows to the height of a man.

Next morning our interpreter, one of the camel men, Kako our guide, and Abulker, an old one-eyed servant of twenty years' service, went to Furzi, the Sultan's residence, to fetch three camels to complete the ten bought, as there were not enough good ones among the stock he had brought here. This meant wasting at least another day at this spot, but we needed the full number to complete our caravan. During the day Maconnen, one of our boys from Addis Ababa, disappeared, or rather, as we concluded later, was seized by the Danakils in the forest as he was out watching the camels grazing. The Sultan's departure had evidently emboldened the savages.

During that night the Awash, which had been rising gradually, a little every day, rose considerably. It rained during the night, but the flood came from far higher up. It rained more in the morning, getting heavier and heavier, and the river rose higher and higher every minute, as the effect of the plateau rains which reached here from some 400 or 500 miles away. The bank was high here, but in the evening we became alarmed at the sudden rise in the river, 10 feet in three hours, so that it was now only 6 inches from the top of the bank. Alio, the guide supplied to us by the Sultan, with his silver baton, insisted that we could stay where we were as the river would not rise farther here. But we dared take no chances, so we moved camp to a place of safety only about an hour or so march away, on a nearby hill; but this proved a very rocky place so full of irregular stones that there was no level space for a foot to rest. In the night hyenas came very close and woke everybody, and the four men with the three camels from the Sultan too arrived late when we hardly expected them till the morrow. They had met with difficulties when fording the river, and the durra had got wet, but we were glad that they had come back, so that we were now ready for the last great trek.

Next morning, May 25, we found the desolate place we had chosen so exposed to the sun that we had to leave our baggage there and the men clearing the durra to guard it, while we found shelter below the hill under some trees on the half swamped plain where the water had not yet encroached. Pastori and I tried to reach the Awash to see what had happened in the night. We were much astonished to see that Alio's assertions of the previous afternoon were justified. The site of our old camp could be seen in the distance, for the floodwaters had not risen to the bank but for several miles had kept a bare 6 inches below the rim. It was evident that there was an overflow somewhere, further proof of the sagacious work of the Arabs imported here generations ago by the old Sultans to establish a sound irrigation system in the heart of Aussa. We spent the morning under some trees at the foot of the hill where the temperature was bearable, but in the sun it was terribly hot. Some of the ground here was so cracked and the columnar structure of the clay was so subdivided that there was no footing at all, and walking was very difficult. Camels could not possibly

cross such areas. In several places during our two-months' trip we had experienced similar ground, but none was so broken as this.

In the evening, when we were at last ready to start on the final stage of our journey, a great Kamsim arose, and the dust was so thick that it nearly obscured the sun. At last we started, well supplied with water, as we had to cross the Kurub or Sardo desert, and after leaving the hillocks, so rocky as to hinder our progress, though we were descending, we reached the edge where the desert begins. An unlimited plain stretching in every direction was soon to be opened to our eyes. Sandy, clayey, crisp or sticky in places where the rain had touched it, going was heavy, and it was in every way a dreary journey, especially as night was coming on and the sun had set behind heavy clouds while the new moon only spread a diffused light. We travelled in this depressing expanse for five hours, making north for Kulsu Kuma and finally passing it and reaching a part of it called Gaile at 10.30 p.m., where we camped in the desert. Upon leaving the hillocks going north towards Kulsu Kuma I took the two sketches reproduced here (Nos. 7 and 8).

We left at 6.30 a.m. next morning and marched for five and a half hours through terrible desert where low hills and small plateaux of basalt stood out black like silhouettes against the dazzling white sand. We found beautiful rounded pebbles of all sizes in this sand, so exactly spherical as to seem like marbles. Rosina kept making collections of them. At one place we saw four wild asses as large as mules and with a reddish coat, also a few gazelle, and we wondered on what they could live in this desert spot, but they must have been wandering to a better region. But what I shall never forget is the heat we went through this morning, and which I quite expected would last for all twenty days ahead of us to Assale. (Actually the journey from here took exactly a month instead.)

We camped at noon again in the middle of the desert, with no end of it in sight. After 8.30 a.m. the heat had become unbearable and it remained so till 4 p.m. We left again at 6.30 p.m., after the sun had just set behind Mount Kurub, hoping to find water in three hours or so, but actually it was not till 11.30 p.m. that, after five hours' march, the third and last on this stretch, we arrived at the Sardo watercourse where we had been told there was a waterhole; and here all the holes were dry. We were so exhausted, men and beasts alike, that we simply dropped down and lay for a couple of hours as we were. The strain of these three forced marches, of sixteen hours actual going out of thirty, had been beyond description. The heat of the day, the exhaustion, the dreariness of the desert, which in the moonlight was no less forbidding than in the dazzling glare of day, with no sign of a breeze—all increased the oppression and desolation. The animals, even the two goats, usually very unruly, had followed us of their own accord so as not to be left to die alone.

We woke next morning a little refreshed, but still without water, so we sent men to search in the hills near by, and they returned reporting that they had found some in a hollow. So they went off again with our animals to give them a drink and to bring back a few goat-skins full. Here we were near Sardo, an abandoned village, said to be the Sultan of Aussa's occasional residence, but the present Sultan had never been there and his father only once in his life.

At 7 p.m. we started on again and began to rise at once on rocky hills, barren

and volcanic, which shone black and metallic in the moonlight. The guide we had with us, with the Sultan's commanding baton, a bad-looking man, very sulky and unwilling, called Alio by our men, had gone ahead on his own account, just leaving word with some other men in camp that he would meet us on the road. Now saying "on the road" may mean something in other parts of the world, but in a desert and at night in an absolutely abandoned unpopulated place it has no meaning at all except for the few natives who know their bearings in these parts. So we went on, full of foreboding, fearing that he might have left us for good—quite a likely thing for a Danakil to do, because for treachery, lying, and falsity one could not find worse people.

We soon arrived in a gulch where we found two natives, one of whom was old, with a few goats, and a hut of the portable kind made of matting which housed two women. One camel was outside. These people were wandering about as Danakils periodically do, being a nomadic race. We at last succeeded in persuading the old man to guide us to a water-hole which we had been told was three hours away and from which these people must have drunk in the days they had been hereabout. They had also used that other water-hole in the bed of the Sardo torrent, which we had found that morning with great difficulty.

When we were on the march again, over ground strewn with boulders with cobbles between them, leaving not a square inch of clear ground to walk on, Alio appeared. We continued on our way and kept mainly (for half of the way at least) on the stony bed of the Sardo or Sekkadahara torrent. The animals falling at every second step made the going a painful affair. But in the moonlight there eventually shone before us the surface of a water-hole. Here I plunged my hand gratefully into the stinking water, greenish black as it was, and drank and drank.

We were all so tired here that directly the animals had been unloaded and made ready for the night in a few minutes we were all asleep. The endless chattering, kept up throughout the night in all other instances so far, and which had woken me up hundreds of times, on these last few nights had not taken place.

In the morning when I got up I walked over the boulders a few yards to the nearby water-hole, and never before had I appreciated water so much. It seemed to me that there never was a better shower than this; I kept pouring and pouring the water on my head. And yet it was of a kind which would have been shunned even by cattle in most European places. Horses would certainly have refused it. At this camp, as elsewhere, we had to keep an eye constantly on the small water-hole, as the Danakils—and we had four or five with us—had the disagreeable habit of throwing themselves into the water, washing, and then drinking. Besides themselves, their dirty chammas and rags would also be in the water. They had absolutely no consideration for the others who might have to drink after them from the same water-hole. They were like cattle at a drinking-place, and raised the mud with their feet, walking or sitting in the water and drinking.

Slavery in Aussa was common. During our stay at Aroberifaghe and on our marches before reaching there we saw many men and boys who had been stolen on the plateau, often by Abyssinians, and then sold here. Or they were

members of caravans of slaves bound for the Arab Coast. On their way through this region it often happened that the caravan would be assaulted and all the slaves taken by the local chief as his prize. On the hillocks when we were forced to retire from the Awash owing to the floods, there was a boy who wanted to follow us just as a convict would look for a way of escape. This youth had been stolen at Addis Ababa, then stolen again from the original robber near Mofa, and finally sold for $50 to our worthy friend the Sultan of Aussa, who kept him now to guard one of the hundreds of flocks of she-camels which he owned.

In the evening we got ready to leave after sunset, after taking in water for the dry stretch ahead. At the water-hole it was sad to see birds and animals coming to drink full of fear at the unexpected presence of man. Sitting on a vertical cliff some 20 feet above I watched dozens of desert partridges flying and soaring about timidly trying to approach the rocky bowl. Also dik-dik came, and the poor things were as scared as rabbits. But they conquered their fear and finally came down to the hole.

That night we had the roughest of passages amongst boulders for four hours out of five, with not a square inch of clear ground. It was far worse than walking on a quarry. We had had two marches already on rocks and the camels could hardly go on. Five times they fell, and almost every one of the twenty-eight had to be reloaded. Their condition was pitiful, for, being soft footed, they suffered greatly on rocks. And these were rocks indeed: basalt with sharp edges and lava, hills composed entirely of boulders varying from melon size to large masses of rock, and all thrown piled up together. Finally we camped for the night in the midst of it all, on a granite hill, after a dry march of five hours. Alio the guide had said that there was a water-hole somewhere among the hills, but in the moonlight we could find no trace of water in that rocky region.

Next day, May 29, we had another hot dry march. We left at 6.30 a.m. and for four and a half hours continued over rocky ground. The heat was terrific and the water we carried very scanty. Three times we tried to descend into the Sekkadahara valley, but the cliffs, a mass of boulders, made it very difficult. In the end we found a way down and saw on the descent looking due east the beautiful sharp pointed Iralale Mountain with its surrounding smaller spikey peaks (Sketch No. 9). We arrived at last at a spot with a few half-dead trees and camped there under a sheet, intending to move off again at night. Thus we had covered three stages with about fifteen hours of actual marching without finding any fresh water. Our mules, I feared, would die through lack of it. None of the precious element we carried was now wasted, every drop was treasured and rationed out to each man and beast.

As we were getting ready to go that evening Alio showed signs of dissatisfaction. This wretch wanted to leave us as he disliked the rationing of water. Apparently he did not mind at all about leaving the caravan to sure death. Earlier in the day he had been off to look for water, and we had sent other men too in different directions, but they had all returned without the good news. We had, in fact, lost our way—no light matter in such a desert region. We reserved enough water for one more stage, however, it was all we could manage, and then moved off in a very sad state, fearing the worst. The Abyssinians

had been told to watch Alio in case he tried to escape, and as these races are deadly enemies they would soon have made short work of him if he had attempted to make off.

As we were drearily marching on in the moonlight to our great joy we suddenly saw a small caravan unloading on a terrace. It consisted of a few donkeys and four women carrying mattings to exchange for durra in Aussa. All rejoiced at the sight of people after the thirty hours spent among the rocks, for we knew that they must have come from some place with water. In fact, they told us that the hole we expected to find ahead had water in it and that we should find it in a rocky hollow. So we departed, all the men singing away in happiness now, and even the beasts going better: the sight of other animals must have given them courage too. The two surviving mules, which we tended with the utmost care for fear of them dying, now walked ahead of their own accord, not needing the stimulating voices of the men. We had not ridden them for some time now to spare the poor beasts; they merely carried a saddle and a few water-bottles. A little later two men and one woman with three camels appeared. They were members of the same caravan, but these people send their women ahead when there is a "blood feud" between the tribes, as a sign of a peaceful mission.

We continued, the road now being less rocky and in one place sandy and clayey, a refreshing patch to our sore feet. After three and a half hours' march we arrived in a gulch, and found water at a hole called Gaddaeita, very muddy but most welcome. We drank with joy and the animals too, keeping their muzzles in the water without lifting them longer than I have ever seen thirsty beasts do before. So we settled for the night, having gone back 500 yards for a better camping ground, and the camels arrived very soon after us. It was cool and pleasant, but I got no sleep, as the hungry camels kept tearing down branches all the time from the few thorny trees around us, and Osman, one of the men, who was sick, was groaning in the distance all night.

As it was very hot next day we remained till evening at Gaddaeita water-hole. When we were getting ready to leave, Pastori and I went ahead to see to the proper filling of the goat-skins. It was dusk and swarms of partridges disturbed at the water-hole were fluttering about and crying overhead. These birds, which drink at sunset only, often indicate by their evening flights the localities where the water-holes still contain a little water. Perennial water-holes are rare, for the merciless sun dries up everything, and even "perennial" holes dry up if the scanty rains delay. It was a sad sight to watch the partridges, disturbed by our presence, circling wildly above us in flights of fifty or a hundred, and in their fright often striking the thorny branches of the scattered trees near the water-hole. Even the snakes echoed their cries, their *glu-glu-glu* and sharp staccato whistling from amongst the rocks showing that we were intruding on the lonely inhabitants of this desolate spot. No other sign of life did I notice there, not an insect or an animal, only the partridges at sunset and the snakes crying at the hour which precedes nightfall or announces day.

We moved off at last, the narrowing gulch echoing the voices of our men. It was a strange sensation to be shut in in that narrow rocky gorge among the blackest of shadows, with the moon now appearing over the edge of the canyon and the string of camels patiently labouring in silence urged on only now and

then by the voices and guttural refrains of the men encouraging the work of the poor beasts.

At the end of the descent of this canyon we came into the fan-shaped mouth of a valley, and skirting the edge of the basalt hills crossed the plain, the first flat ground we had covered after several days over the roughest boulders and crags. A range of hills now showed up in the moonlight ahead of us and, climbing a saddle, we descended into a unique crater. A perfectly level circular plain of some 2 miles' diameter stretched before us, pearly white, of fine, velvety clay, which looked like snow in the soft moonlight—a sight not to be forgotten in a lifetime. A break in the volcanic rim offered a route down into this perfect ring, so we descended and moved over that pleasant surface with relief inexpressible; after the trials feet and hoofs had suffered, going was so light that we felt as if we were walking on air. A light breeze now and then soothed us, though the wind was hot. A perfect circle of black hills stood out in silhouette around us, but on the crater plain not a sign of life or vegetation: absolute barrenness and the most frightful desolation, a sight which must spell thirst when seen by day.

At the farther rim of the crater we marched along a gulch, a crack of volcanic origin with steep sides, not long, but promising hard going on account of the stones and boulders piled on top of each other as against a sea jetty, some of enormous size, fallen from the edge of the vertical cliffs, some seeming to menace falling at any time, and all a maze of black shadows and shiny metallic surfaces. From this gorge we entered a second crater, even larger than the first, with again the same contrast, a passage of the roughest going leading to a plain of the smoothest, talcky clay, with a surface like fine powder.

We continued at a good speed, crossed the farther rim of the second crater, both named Hariri, and skirted a vertical cliff at whose foot immense boulders were piled in confusion, and where these ended a few thorny trees attested that we were in more refreshing country. But no signs of actual water, permanent or recent, were visible. The small tufts of dry, toothpick-like grass showed no fresh sprig or leaf in their centres or underneath the dry growth, as proof that rain had lately fallen. The hands of the two boys and guide often went under such tufts in search of new vegetation, but none was ever found. We continued and came into a third crater, this of enormous size so that the distant rim was hardly discernible.

We thought the edge was all around us, but as we went north farther and farther we came on what I may call an islet in the middle of the plain itself. This was a range of hills basaltic, black, and prohibitive, rising abruptly from the snowy white clay plain around: another very strange and wonderful sight. It showed for quite a distance ahead, stretching northward along our route, till it faded away to mix indistinguishably with the rest of the border of our horizon. The Great Bear and Pole Star, so clear, had guided us, and it seemed a coincidence that in almost all cases when we traversed big plains we steered almost exactly due north. Here too the case was repeated. This straight range continued, narrow, tall, upright, in an almost perfect line, pointing to the navigator's star, starting from the centre of the crater and running north as a solitary radius drawn in black in that immense circle of white. We followed the same course, our most direct one too, leaving this long hill to our right,

having thus entered the western division of the Datoma Alidas plain, the immense crater, the third we had found on this momentous night march. Here we came very close to the desolate tomb of the chief Datoma Alidas who gives his name to this horizontal expanse, and to the range which divides it in its centre. This was the only sign of a tomb we had come across for quite a distance, the last one having been seen on the edge of the boulder hill where we tackled the descent to the Sekkadahara valley with Mount Iralale in front of us to the east. The Sultan of Aussa commands an immense territory extending north as far as one day beyond Harak, which was four days beyond the point we had now reached. Thus some twelve days of hard going separate Furzi, his headquarters, from the northern boundary of his territory.

We continued on and on, tired after now four hours' going. We had left at 7.30 p.m., only the occasional wind cooling us and the prospect of meeting water at the end of the night's march keeping us going, for men and beasts would willingly have fallen asleep anywhere on the march. I could barely see the road, my head often refusing to stand upright, and my eyes not seeing where I was walking, so tired and exhausted was I, and the others were the same.

The guide said that we should find water at the end of the straight Datoma Alidas range. We had been following it for a couple of miles when the crater began gradually to narrow down. The first signs of sparingly scattered rocks reappeared, then these thickened, and we were soon again in the domain of stone and boulder. We climbed up, crossed the dry bed of a torrent, climbed again, and at the very end of the range traversed it, leaving to our left as the last sign thereof a rounded cone almost perfect in shape, a veritable mamelon rising on the northern spur of this curious long straight basalt range.

From the height, before the descent began, we suddenly had a view of a plain lying below vaguely discernible in the moon haze and stretching to a great distance, our future road for the morrow. On our left the canyon into which the dry torrent we had crossed half an hour before found its way with a sudden jump, was gaping fearfully like an open wound, one side in black shadow, leaving only an edge shining like metal in the moonlight. We began the descent to the level of the plain below and of the dry torrent-bed on a zigzag path most dangerous and precipitous. Our poor camels were moaning and groaning at every step. We thus descended some 600 feet, taking a considerable time, often doubting whether the camels could ever make it. We in the vanguard arrived on the torrent below and found a camping place right at the bottom of the canyon, luckily now illuminated by the moon at its zenith. This light allowed the camels to descend painfully. Only two lost their way with a small group of men. These, a few hours later, came through another gap, with one camel lame. The water-hole in this gorge, which the mules soon found, is called Galeie. It is not a permanent supply, but could last out five months if the rains were delayed.

The preparations for the night were soon made, the unloading proceeding amongst boulders hardly offering space from one to another for a camel to lie down and be relieved of its burden. Usually these ponderous beasts require even the smallest stone removing from under them to avoid hurting them, as they never look on the ground, but put their feet down anywhere below their

neck. But on this trip things undreamt of happened: at first we were careful to remove stones even on the path and to think many times before attempting a small rocky climb, hoping to avoid it and to find a fully earth-covered one. Since then however we had scaled mountains and gone through deserts of boulders and rocks, where progress would be trying even to a goat. But thirst is a great stimulus to go ahead, when to return would be even harder.

I had my bed made beside a huge boulder close to the vertical cliff of the canyon calculated to give me as soon as possible a shadow from the moon rays, and no sooner had I fallen on my bed than its face disappeared behind the sharp outline of the canyon rim. Complete darkness was thus on my side, with only the good stars above, and to the north, ahead, the turn of the gorge hid everything in the blackness of the night. To my left the opposite wall of the canyon was still fully illuminated by the moon, but was soon to be obscured as only 60 feet separated the two abrupt sides of this fearful gap, silent in the night and as awe-inspiring as a tomb. Not even our men were heard, and beasts and all fell to rest as best they could amidst the boulders. It was after 1 a.m. The night was not hot and often a breeze cooled the furnace baking rocks surrounding us.

We awoke with the first light. It was impossible to keep one's eyes closed after dawn here. The light was so strong and came so suddenly that one awoke perforce, so we only slept till 5.45 a.m. The short nights were already telling on us. We could never get more than six hours' sleep, even after long marches, as most of our travelling was done at night and in the early morning. We were all getting very thin, and our men looked very different from what they did when they started, and the animals too, from lack of food and spare drinking. Our food was boiled rice, tea, coffee, barguta,* and meat; but we felt no desire for eating. Our last goat would have to be killed next day and then there would be no more meat except of the dry kind.

The little crocodile which I had caught newly hatched at Aroberifaghe and managed to keep ever since in a kerosene tin was still alive, but his tank leaked, as did all the water tanks too, having been strained so often with rope when the camels were being loaded that they were all out of shape. I hoped that the poor little fellow would last out, as I liked his way of calling and answering quickly. We spent the next day at this gorge, where it was very hot. Just before we were going to leave I went down to the water-hole to wash. It was a deep hole in vertical black basalt from the rim of which a huge boulder had fallen to the bottom. There were a few grottos around the bottom which was covered with a peaceful sheet of water. In the dark shadows of the evening I plunged into the water, surprised to find how cold it was below. I swam around enjoying the bathe in a way that I shall never forget. There was no need for a towel in that hot dry atmosphere.

On returning to camp I found operations for leaving suspended as two camels were missing and several of our men had gone after them. We waited long until it became dark, when we decided to stay here till the next morning, should the camels be found in the night, or if necessary all next day to look for them. We settled for the night, partridges, as at Gaddaeita, flying around in despair at

*A kind of bread made from durra flour mixed with water and cooked round a hot stove.

not finding their water-hole free. Our camels had gone to the water-hole to drink, and as we did not leave, had stopped in a patch clear of stones, offering them for once a fair surface to rest on. The partridges flew about for some time above, and at dawn started again, crying and crying, and my little crocodile every now and then answering. The poor birds came so close that I was afraid of my mosquito net getting torn.

Next morning, June 1, I climbed to the edge of the canyon, the eastern rim of the terrace, and walked on the plateau above, where I enjoyed one of the most attractive landscapes I had seen in this country. I took the four sketches (No. 10) showing our route over the Datoma Alidas plain, the water-hole gorge, and the valley ahead of us. We spent the day in the grottos over the water-hole, in beautiful shadow where we could safely be without a helmet—a great relief from that oppressive weight. It was pleasant to watch birds and rare squirrels coming to drink, especially the colibri, a very pretty bird, blue-black with a green throat and a red collar below. The squirrels had a rough bushy tail and most a coat of coarse hair.

At noon the men who had gone to search for the camels came back saying that they had been found. They had gone on to a water-hole three hours ahead, where we intended to make our next stop. We then spent the remainder of the day with our minds at rest, in the cool shadow of our grotto.

We left in the evening, fully rested after this twenty-four hour delay. Our camels had benefited by it too, also the lame one, which lifted one of its hind legs so high at every step that it was a funny sight to watch. The two surviving mules still kept alive, to our wonder. We felt that they might die at any moment. On leaving we noted four good tombs, three of which were circular. That night, after three hours' march, we arrived at Gwia, a temporary water-hole in the dry bed of the torrent of the same name. It was quite a novelty to see good-sized trees and to camp on sand and gravel instead of between huge boulders. The smell of the jasmine in the night and the air cooled by a soft breeze were delightful after the desolation and heat of the last marches.

We spent next day at this spot where the dry watercourse, plain, and water-hole all bear the same name. The water was very bad, disgusting in smell, so we got ours from another water-hole called Bodaito, below Mount Askoli. In the afternoon I climbed the Datoma Alidas hill which was right at our back here, the Gwia torrent curving round the hill, a branch turning south-east, and losing itself in the soil in what looks as if it would be a small marsh in the rainy season, while the main stream turns north-east. I took a good look at the beautiful panorama surrounding me on that small eminence, the climb up which had been easy and reminded me of the ascent of the Pyramids, the stones here being naturally arranged on one side in steps at about the same distance as in the famous Egyptian monument. Towards the extreme end and on the opposite side of this hill lava appears to have flowed down to the desert.

All around us was a landscape of the most desolate and volcanic aspect, but the first noticeable feature was the ruggedness of the Hela chain, a true saw, a jagged red silhouette. Between it and the Datoma Alidas hill were five gently sloping ridges formed by parallel lava flows, of which the Datoma Alidas hill might be said to make a sixth. A terrific storm was raging over the Gohoi

plain and we enjoyed the spectacle of the columns of rain falling to our right without a drop reaching us, though we were so close to the downpour.

We intended to leave the same day, but the new guide, or rather the supposed one to assist Alio, who felt uncertain about the future ground to Harak, was to have come that day, but after presenting himself (he was a sort of a petty chief) excused himself for the day to go off and assist in a fight near by concerning some cows and goats. Having no alternative, we had to comply with his wish. He came armed with rifle, both hands on it, raised, as is the custom here, to avoid the heat of the arms against the body, and robed in a leopard skin, a red kerchief wound around his head, and a big double-edged knife in his belt: quite a picturesque figure. We had to wait here, as it turned out later, in any case at least for a day, as we lost another camel, and especially because one of our camel-men, Mordofa, a plateau fellow, was missing. We searched for him next day, but could find no trace of him and sadly realized that he must have fallen a victim to the Danakils. The camel also was never found.

In the morning I climbed the northern end of the Datoma Alidas hill and made three sketches (No. 11). At 6 p.m. we left with the guide, a full moon rising behind the lava ridges to our right. The plain offered good walking ground, and we made fair progress. Only at two places did we meet rocky ground, and this was where we changed directions from due north to north-north-west, in both cases to resume our original bearing again after a short time. On our march we passed twelve tombs and also came on what appeared to be an abandoned Danakil village but the people are so nomadic that a permanent residence means nothing to them. We also passed two groups of flat tombs and then twice crossed the torrent Galaito, which is formed by the union of the Gwia and Assa, and followed it over flat ground till it suddenly entered a rocky ravine, where we camped beside the water-hole of the same name. The brilliant moonlight and great heat that night made proper sleep impossible.

We spent half the next day on the east side of the ravine, under the overhanging rim and the rest on the opposite side, as the sun shifted. Several snakes came out of the rocks, but we had by now to a certain extent grown accustomed to seeing them. A small party of Danakils looked down on us from above once during the day, but took fright when we looked up at them. In the evening, just about sunset, I climbed the hill on the eastern side of the canyon and hurriedly made three panoramic sketches (No. 12). From here I had my first glimpse of Mount Afdera to the north-north-west.

We moved off at 7 p.m. and the first two hours were as sore a trial as those memorable marches of the past days, near Sekkadahara. Our camels were falling every few minutes and had to be reloaded scores of times. Their groaning was the only note in the dark night, as the moon, to complete our handicaps, only rose at 7.45 p.m. when due to appear at 7.15, through a mountain intervening. We marched on till, after a steep descent covered with boulders, we reached a flat crater scattered with a few tombs, where we found better ground for the rest of the march. In the first two hours we hardly progressed a mile and a half. We then marched for two more and made 5 miles, *i.e.* a total of about $6\frac{1}{2}$ miles for the night, and camped on a flat near the torrent-bed, the same dry stream we had followed from Gwia and which

would take us to Harak. Though there was no water here, there was some quite near at Dackbwie hole.

Near the edge of the steep boulder-covered slope leading down from the terrace to the crater below, just near the river, where the cyclopic masses of basalt and lava seemed to have been piled up on purpose to form a limit to that dreary plain of stone cracks, edges, and blocks, a most beautiful tomb stood out in the moonlight—a strange landmark in that infernal scenery. The background was a rugged silhouette of the Hela chain, and the sight was so impressive that we all stopped to contemplate the wild scene, and I had to return the next day to see it again and sketch it, so struck had I been by it.

We camped for the night and had some sleep, though it was hot and somewhat sultry. Two of our men were now sick and we ached all over and our feet were in pieces. We had one camel lame, one with the skin on the shin split, and several with big cuts in their softly padded feet. The hardships we had gone through and were going through were beyond telling, and these places were certainly not fit for camels. It was the greatest trial for the poor blundering beasts to find a way amidst boulders and rocks when even to ourselves it was a constant feat of equilibrium to keep upright. We had to walk on the edge of stones all the time, often for an hour or more without resting the sole of the foot on a flat rock or patch of soil or sand 6 inches square.

I went back in the morning to take a photograph and sketch of the beautiful tomb I had seen last night. The spot is called Agulio. It was farther back than I thought and the heat made the trip very unpleasant. Nevertheless I was glad to have returned. Later I turned aside to a hill to the left where I had discovered on the way there the implacement of a fairly large cemetery, and there I took another picture.* Two Danakils came down a mountain to see what I was doing, and showed signs of friendliness. My surprise and disgust therefore was great when in the afternoon of the same day the two men appeared in camp just when we were about to leave and said that I had violated their tombs, walked on their broken stones, etc., and that they were going to raise their tribe against us if we did not stop and thrash the matter out. It was some time before our two guides could dissuade them—and another man who had followed them, the three fully armed—from further discussions, and they would allow us to proceed.

We started eventually at 4 p.m., after loading in terrific heat. It must have been 110° F. now in the shade, though about noon it was at least 130° F. As we left the river-bed at Dackbwie we soon climbed on to a terrace, a lava flow so broken, like all the previous similar ones, as not to leave room for the foot to rest flat for a single step in the thousands taken. We were walking all the time on edges or on rounded stones which rolled away under our feet for an inch or two until they stopped against larger rocks, and all in the dreariest of landscapes, the most awe-inspiring, fearful, and prohibitive that could be imagined. We continued, often waiting to assist the camels with their loads, which would hardly stay on their backs, while the poor beasts were continually performing feats of equilibrium. And after four and a half hours of such hardships and sore footedness, as the light had gone and it was getting dark, we

*Sketches of several of these tombs and a note on Danakil methods of burial will be published with the last part of this paper.

stopped at 7.30 p.m. on a tiny patch of flat surface on the lava flow. We had done 8 miles that day over terribly rough ground, but on the whole had managed it fairly well, as it was daylight. If it had been night, in moonlight, we should have taken three times as long. Our feet were aching all over, being covered with bruises, and what the camels were suffering one could only imagine.

Meanwhile we had descended a little, the lava flow sloping towards a plain where ahead of us lay the Harak region. We hoped to arrive there next day or the day after. We also saw in the distance in front of us to the north-west two imposing volcanic cones, Mount Alaita and Mount Afdera, the second reported to have produced a violent eruption as lately as 1915, which brought destitution to many of the few natives who live on the plain below. On our immediate right were three absolutely vertical ridges, indicating three canyons, and behind them a chain of almost vertical-sided mountains, called the Auginnale Chain.

We settled for the night, after our usual evening or night meal of late—*barguta* dipped in a little oil, salt, and pepper. Since leaving the Awash we had not felt any desire to eat meat. The heat repelled it. We took a little soup or rice at noon and at night that heavy leather-sole-like *barguta*. Even if we had wanted meat the few Danakils we met who owned but scanty flocks of goats refused to sell us any, even when we were in Aussa, in spite of the silver baton of command given to us by the Sultan and carried by Alio. Alio had changed for the better since he had become accustomed to Europeans. We had hoped that Mordofa, our camel man who had been missing since Gwia, might return, but he never did so. He must have been seized or killed by the Danakils, for he disappeared without provision, and had a little money, all his earnings almost, to collect, being a fellow of very spare and economical habits.

I awoke at 3.15 a.m. next morning and at 3.30 a.m. the men were called to load the camels. We left at 5.30 a.m., the moon ceding to the light of dawn, and travelled for an hour and a half on the same painful lava flow to where it gradually sloped to the plain below. The line where the volcanic rocks ended was sharply demarcated, and with joy we set foot on the level clayey horizontal expanse. The water-hole of Dedda was on our right, near where the first canyon started, being at the line of junction between the lava flow and the first of the three parallel vertical ridges which ran from the extreme north of the Hela chain into the plain ahead of us.

With Rosina, I spent the morning till luncheon time in a hollow near this small sheet of water which lay at the bottom of a circular hollow amidst the basalt boulders, a water-hole of very reduced dimensions and storing greenish water which would not have been considered fit for washing a cab in Europe but here was most welcome. Two women came down to fill their *girbas*. These people had watched and known of our arrival, and six or seven of them had flocked from some native camp to see us; a couple of men also appeared and two or three boys, one of whom we all noticed for his good looks and countenance so much above the average.

The day was hot and we felt it when we left our retreat to return to camp for our daily soup and coffee. The slight wind now and then blowing was like a blast from a furnace, it burnt the face and hurt the eyes. A temperature of over 120° F. in the shade and the radiation from the black metallic surfaces of

basalt and lava increased the ill effects. We stopped under the tent for the rest of the day, not daring to expose ourselves more than we could help.

After travelling that evening for three hours we arrived at the bed of the Tio river, with beautiful fine gravel. Here we stopped for the night, and the next morning at 3.15 a.m. resumed our trip. We kept on the river-bed which brought us into a canyon with vertical basalt sides some 300 feet high. It was an impressive sight and the strange spherical obsidian pebbles and boulders surprised us even more here than they did in the past days when we had walked at times for hours on them. The basalt sides, black and steep, cut the view ahead of us and made the place the fit site for an ambush. The sun rose, but mercifully the day was cloudy. We passed two or three small water-holes and after many curves of the dry torrent-bed arrived at a very good one sunk deep in a rectangular hollow in the bluish basalt. We continued however, and at 7 a.m. our trip was ended for the day at a spot where a few genesta bushes offered some food for our camels, which had hardly eaten anything of late. The mules were being kept alive on durra which the camels always tried to eat for them. We were settling down after unloading, observing the vertical chalk cliffs of the left side contrasting with the black lava and blue basalt on the opposite, sloping upwards to the barren nearby hills, when report came that Dimsa, one of our men, had turned up, but not Wolde Johannes. Now Dimsa in the afternoon of the day before had felt sick and had had to ride, as he could not walk. This morning he said he felt better and was going to walk, so he trudged behind the line of weary camels. Rosina and I kept the rearguard, as the last struggling beasts and men had to be urged forward and to a certain extent watched from possible hidden attacks, the lie of the country being such that one man with a fair rifle could in a few days pick off a large party by following and keeping out of sight. Even night marches would not save a caravan here. In the first light of dawn it would offer an easy target from behind rocks or the rim of the canyon. The Danakils here would secretly follow a caravan which included Abyssinians and at the first occasion of one lagging back, kill him, the greatest glory to these barbarians deriving from the fame of having killed a Galla or an Amhara. If the murders committed can be counted as several the criminal becomes a hero deserving a monumental tomb and a tree before the entrance thereof whereon to hang the skin of the victims if available or the dried remains of them or a leopard skin in the absence of a human one.

We had been marching thus when Johannes also dropped back, and rested on the rocks by the way. We had thus had two men lagging behind, and we had often turned back to look for them, but presently did not see them appear. As we had known that the trip would be a short one however, we had not worried as we thought they could easily catch us up. When Johannes did not appear half an hour after we had unloaded, several men went back to look for him, but returned with negative news. More went and explored the vicinity for an hour, but could find no trace of him beyond footprints in the sand, which soon disappeared amidst boulders on which the solid lava flows joined. We then grew quite alarmed as to his fate and organized a better search party, which now went back with Pastori. At twelve noon they returned, bringing back Johannes. The unfortunate man had been turned crazy with sunstroke, and was wandering to sure death on the lava flows in the opposite direction to

where we were. Had one hour more elapsed he would have been dead of thirst, as they cannot last here, men of the high plateau as most of ours are, more than three short hours without water.

Since leaving the Awash river-belt of trees and pasture we had seen no animals to speak of, only rarely goats and camels, never a horse or a mule or even game, and since on the desert and lavas, not even flies or birds or insects or living thing outside of a few serpents near the water-holes and sometimes partridges and small toads under the moist rocks where the scanty water-supply lay near by.

We settled for the night, after a swim in the Tio water-hole, very pleasant after the heat of the day, but the strong hot desert wind, when we returned to camp, soon took away the pleasure of the dip. It was very hot for the rest of the evening and we could hardly sleep through it, and the strong wind was blowing sand by in clouds. Rosina tried to sleep on the ground, but found it impossible. We two others were under the cliff, where it was very windy.

After careful investigations which had extended over many days, indeed practically since we had entered the Aussa Sultanate, we obtained clear proof here at Tio, chiefly through Alio's declaration, and later from events which followed, that this was the spot where Bianchi and the other two Italians of his expedition were massacred in 1884. The site of the massacre had hitherto been unknown, as no one had passed through this part of Danakil since that year and no news of the ill-fated expedition had reached civilization beyond the fact that it had been entirely wiped out. We found no actual traces of the expedition, but these were not to be expected in such a desert region after nearly half a century. The Danakils do not bury their enemies, and beasts of prey would leave no sign of them after a night or even a few hours in the open. The elements, wind and sun, and sand storms in any case would be enough to obliterate all traces after a short period in a region where temperatures reach 170° F.

Wishing to commemorate our ill-fated predecessors, we were starting to erect a cairn in their memory, but when we were about to put a few rocks together and leave a written word, several natives appeared and protested. They were so threatening that we decided that we must leave without doing so as the risk of irritating savages here is only to be understood by a traveller in similar regions. Urged also by our men to leave Tio and avoid irritating the Danakils by any further attempt to erect a cairn we therefore left at 3 a.m. next morning, June 8, in order to take advantage of the moon and comparative coolness of the night, as travelling by day is generally out of the question. We travelled on the bed of the Tio torrent amidst obsidian pebbles, good hard gravel, and often loose sand where walking was heavy and slow. The landscape was very beautiful though grim, the sheer cliffs of white chalk contrasting with those of black basalt and coloured trachytes, and the grottos and hollows dug by water action in the chalk. At one point four rivers—or better, torrents—met. It was a wide place which in the rainy season must be an eddying pond.

We came out of the canyon very suddenly, after a small bend opening into the desert: an impressive sight, a plain, sandy and dreary, dune-covered and ripple-marked extending everywhere ahead of us to where dimly in the distance could be seen a range of black hills, a sight to depress and make one's heart sink at the thought of the possibility of water shortage. Our route turned

sharply northward as we came out of that strongly defined canyon neatly cut through layers of chalk and basalt which on both sides continued almost at right angles to our exit as a straight border to the desert spread out in front. The abrupt step down to the desert level from the chalk and basalt terrace formed a straight edge, a rim of white dazzling chalky cliffs, here and there topped by a black spread of volcanic material. Grey sand-dunes were piled against the foot of the cliff, some ripple-marked so finely as to give rest to the eye, had it not been for the whiteness of the cliffs throwing a glare on them.

We now kept in a due north direction, marching a few hundred yards from the edge of the cliffs and parallel to them. No signs of life of any description were met here. To our right in the far distance a line of chalk cliffs ran parallel to the near one on our left; and beyond this the black volcanic hills; to the south higher ones, and to the north the infinite horizon lost in the haze of the desert. Three prominent cones rose from the haze in the distance, one south-east, one east, and one north-east. A landscape of terror, of hardships, of death, horrifying, though in a different manner, like those of volcanic bareness.

We skirted the cliffs, keeping on the edge of the sands of the desert and travelling northwards all the time. A gap in the white wall to our left indicated the outlet of a torrent. We continued and, some three hours after issuing from the Tio canyon, came to a second gash. Here we turned sharply west and marched upstream, hoping to strike water. The chalk beds eventually terminated, to be followed by basalt. We stopped at the end of the chalky cliff, on its southern side where a natural hollow, the shape of a half-reversed cup of some 24 feet in diameter and 12 feet in height, offered us shelter from the dazzling sun. This devil's hollow, as Rosina termed it, proved to be indeed a furnace, yet its shadow was preferable to other shadows thrown by boulders precipitated from the cliff rim and piled on the sands below. After 3 p.m. however we were forced to abandon it, through the sun coming inside, so we took refuge under a stone on the cliff slope.

During the day four Danakils suddenly appeared, and we gave them some durra and other food, for every one is hungry here. A little later however it was clear that trouble was brewing. They said that two of them were *ascaris* of Yassim, Sultan of Biru, in whose territory we now were, and that they had come to find out if we had their Sultan's consent to travel through his country. They also said that there were more local natives ready to help them, besides the two with them, as the tribe was aware of our attempt to avenge the death of the white men many years ago, which we had begun by trying to erect a tomb at Tio. We showed them that we only had durra for two weeks and that none was obtainable anywhere near, and that our camels were nearly exhausted through fatigue and lack of food. As we could get no satisfactory replies from them however, we cut short the conversation and sent our guide from Dedda to fetch the local chief, as the savages were beginning to collect and were very suspiciously mounting guard over the upper water-hole at the end of the basalt canyon. There was apparently a small village of about a dozen people west of us, concentrated about a few water-holes which afforded life to scanty flocks of goats and sheep grazing on the scattered bushes and spiky grass about their rims.

In the evening I visited the basalt canyon extending to our west, where I went for a dip in the water-hole it contained. The entrance, where chalk ceded

to basalt, was some 80 yards wide, and the canyon then narrowed down most regularly to 2 yards width at the end within a length of 300 yards or so. The vertical basalt cliffs kept their constant prohibitive aspect, and at the very end of this tapering corridor was a wall as vertical as the sides, up to a height of some 75 feet. At the foot of the wall lay a small basin a few feet across and full of water, which though far from cool and rather greenish was nevertheless the essential element we needed. A step higher there was another hole, which some Danakils were guarding. We kept to the lower one, and there I swam and dived and dived. There was a small hollow in front of it which we filled with buckets, and our animals drank from this, the larger basin being separated from it by a group of boulders and a vertical bank which camels could not climb. The water in this upper pool was thus kept cleaner for man's use. While I was there Pastori and Rosina came to look for me, as I had gone there alone and my delay in returning had in some measure alarmed them. They also took a dip and enjoyed the sport as frogs out of a pool for a month would upon being returned to their surroundings. Signs of hostility from the few Danakils gathered there were however apparent.

The wind which blew all day, raising sand and grit to the utmost discomfort of eyes and body, did not abate till 4 a.m. The temperature did not decrease much either at night, as the cliffs, so near our camp, radiated the heat they had stored during the day for a good part of the night. To camp farther out in the outlet of this Gaiara torrent, *i.e.* towards the opposite cliff, would have meant exposing ourselves more to the wind, therefore we kept close to our side and suffered as it was natural to suffer here.

The heat for the best part of the day averaged about 135° F. in the shade. Objects in the shadow inside the grotto where we were became so hot that if they were metallic they could not be held long in the hand. Moving one's hand about one's clothes always left a sensation of great heat, and the sudden touch of a button was rendered noticeable instantly by the heat of it, whether of mother-of-pearl or bone. I slept very badly that night, the wind, sand, and heat making it impossible to rest. Only the little crocodile kept well, with his store of small toads I caught at Tio swimming with him in a kerosene tin.

Next morning the chief appeared with the old guide and another man. The chief was a very old, thin, dried-up man, so wizened as to be the strangest sight. He rested first on a mat in the shadow talking to our guides, and after he had taken coffee—here a precious drink—parliamenteering started between the two *ascaris*, our old guides, the local chief, and the new man. They talked for hours, mainly with us, but every now and then retiring to discuss between themselves. They insisted very emphatically that we must return or wait for Jassim to come here. At 4 p.m. no end was yet in sight. It was not till more than six hours had passed in discussion that an agreement was reached. The two *ascaris* asked $100 to let us go through, but $10 in the end satisfied them.

We now thought we could safely leave, and planned to do so with the rising of the moon, *i.e.* about 11 p.m., the new guide being with us, and the old chief, apparently disgusted with the two *ascaris'* illegal proceedings, seeming all day to agree to the importance of our leaving that infernal furnace. But as we prepared to load he sent word through our interpreter that we could not leave in the night. So he was summoned to us and came to speak, using much savage

diplomacy. He said we could not go, the darkness being against us, and the guide not accustomed to night travelling, and that the latter had to return to his home and inform his family of the trip he was about to take. In the end he said the guide could not go with us unless we agreed to wait till to-morrow evening, because this man must go back to his village first.

As we must have a guide we could only acquiesce, so we cancelled our plans for leaving in a few hours' time and settled down for another night in that awful place. I tried to sleep in the grotto to shelter from the grit raised by the wind which here blew up the canyon from the desert. The heat however was unbearable, so I moved out to the torrent-bed below, but even there could get no rest. The moon rose and it was always hot, dawn came and I was as wet with perspiration as at noon the day before. This spot will never be forgotten by us as long as we live.

Next morning the old chief, whose name was Sunimaa, and on whom we felt all depended, rose, had coffee, smiled amiably, sat on a mat under a stone drinking water from a little *girba*, and then walked to the kitchen, where he remained for some time. Suddenly from this quarter news reached us that there were fresh difficulties ahead, and that a guide would be refused to us. Meanwhile four sheep were calling not far from us. We sent for the chief, and asked what was the trouble now. He said he could not give us a guide after all, but that there were sheep for sale and one as a present. We told him we did not want presents nor were we worrying about sheep, but that we wanted to get out of the furnace we were in, that we had agreed last night to leave to-day in the afternoon, and that we could not understand his behaviour. He said that Yassim, his Sultan, during the night had sent a man to his village to tell him not to let the white men through, but that they must return whence they came, *i.e.* back to Aussa, that the news had been brought down by the shepherd of the four sheep, the Sultan's envoy being now at the village resting. It sounded suspicious, but we could do nothing.

We offered the guide more money to tell us the names of the water-holes on our forward march, but like all others, he refused. Alio, the guide with the Sultan's baton from Aussa, tried to persuade him, but he was very stubborn. He said no baton was known here, besides Yassim did not want anybody here who came from Yaio's son. Things were going from bad to worse. Alio said his responsibility had ended with his delivering us at this spot to this man. The new guide, in his turn, arguing that he had not accepted us, did not want responsibility, and feared his own Sultan. Alio, with a letter from us to the Sultan of Aussa, stating he had delivered us safely, was now ready to go back, and begged us not to venture forward alone, but to reconsider the matter and return with him to Aussa. This would have meant a two or three weeks' detour to Aroberifaghe, as it took us two to come here from there, and we were now in a pretty exhausted condition. And then it would mean going eastward to Tajura and then by native boat to Jibuti, in all a two-months' trip at least, and our ready means were almost exhausted. If, on the other hand, we went on without a guide we did not know the road, and deserts were ahead of us with water-holes only two or even five days apart, meaning anything up to five dry forced marches, or some forty-eight or even one hundred and twenty hours, relying only on our goat-skins for water. The water-holes in this country were

of very small size, often only a few feet in diameter and a few inches deep, sunk in impervious materials, basalts or lavas, between huge boulders in the recess of a canyon, and leaving no traces of moisture around them, nor a sprig of vegetation to testify that the precious element was present. One had to know where the bowls were located or one might pass near them and never see them or guess their existence. One had to know also where there would be food for the animals, though only thorns in a gulch or woody bushes, because though they could go two days without food or drink, as they often did on this trip, on the third they must be sure of getting something to eat.

So we tried offering money again, but the chief said he was afraid of Yassim, his Sultan. Then we told him of our papers and showed him our European passports; he had earlier taken a certain amount of notice of the "papers of Government," probably through mere curiosity. So we made a last attempt and carried the day. Luckily we found inside the wallet which held our papers an odd receipt for $5 for stamps on a pass granted, written in Amharic, just a small piece of paper but bearing printed at the top the Lion of Menelik. We showed the chief that the lion was the same one as on the coins and offered him the paper to keep, telling him that it was a letter from the Negus to protect us, to be given to any chief afraid of letting us through. The ruse won him over, and after retiring he returned and said, "I will keep this letter, you can go. I will give you a good guide." He did not want money, and only accepted a few coins, beads, tobacco balls, and boujadeet.

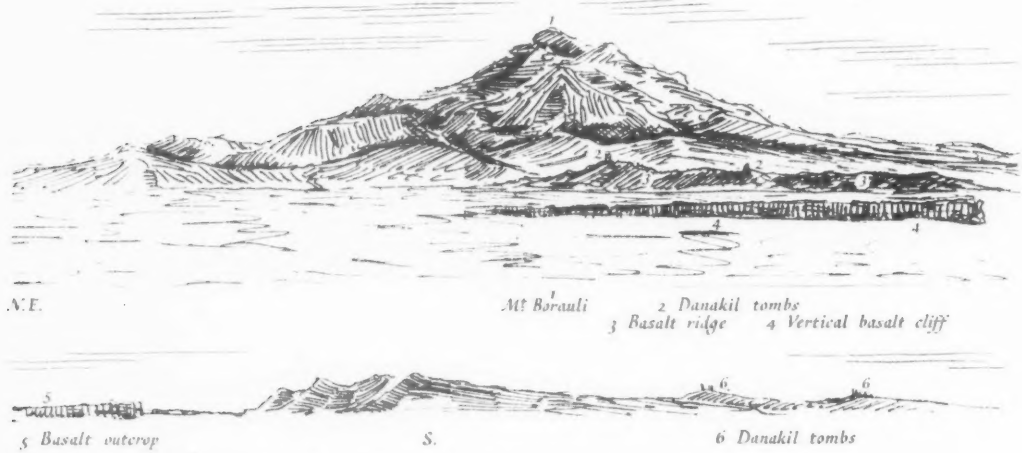
So after a quite touching good-bye to Alio, who had in the end proved a friend, we left at 3 p.m. in spite of the torrid sun, because we wanted to get away to avoid any possible change of mind on the part of Sunimaa. All the time we were in this gorge we had only had the use of the lower water-hole, the upper being guarded by Danakils, and the water in ours had become very foul. Before we started however all possible containers were filled; we had sixteen *girbas*, two kerosene tins, a few small skin water-bottles belonging to the men, and six metal water-bottles for ourselves to drink from as we walked. With this supply we left, after having been held up three days in the canyon. The two men who were sick and the one who was insane were riding camels while three other camels went unloaded but for empty pack saddles which we were keeping for fuel. The poor beasts were so weak that they could hardly follow us. For this reason and to provide mounts for the sick men, materials which had been collected were gradually being jettisoned. We were almost in despair of ever getting through alive, with our food supply so low, our camels so weak, the chances of finding adequate water so small, and above all, the infernal temperature and blazing sandy desert ahead of us. In spite of the heat of the afternoon however, we plunged forth into the dazzling baked sands of the Harak desert.

(*To be concluded.*)

7. Kulsu Kuma from desert plain west of Mount Borauli. May 25.

SKETCHES IN DANAKIL, 1928.

by L. M. Nesbitt.



8. *Mount Borauli and view looking south from desert plain south-east of Kulsu Kuma. May 25.*

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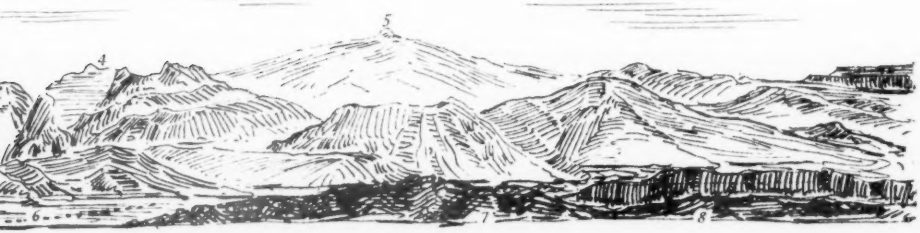
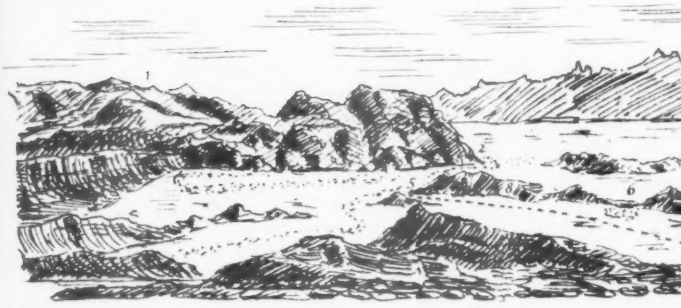
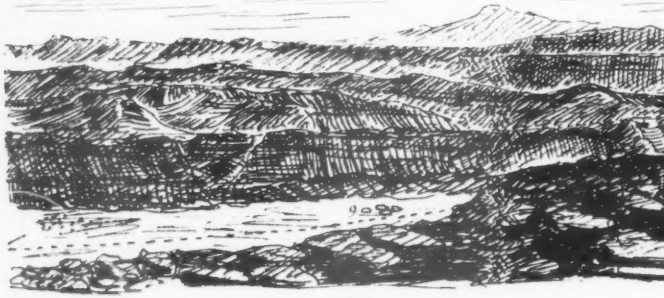
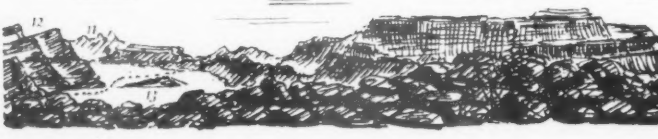
9. *Mount Iralale from terrace rim above Sekkadahara valley. May 29.*





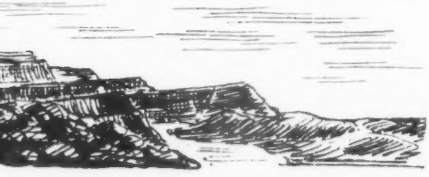




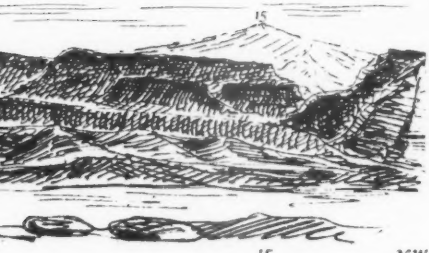
10. Complete panorama from terrace above Ga

4 N.E.
Volcanic cone
3 Hela Chain
6 Sigarita W.H.
7 Parallel lava tongues
8 Datoma Alidas Hill

10
Galeie W.H. in canyon
S.E.

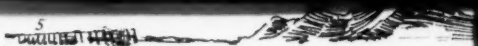


S.W.



15
Mt Gaddaelo
N.W.

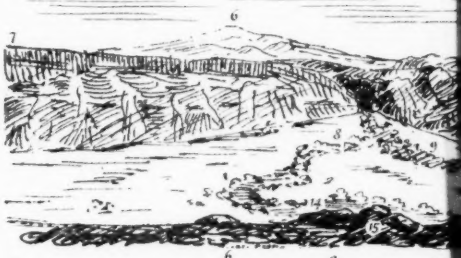
...ove Galeie canyon. June 1.



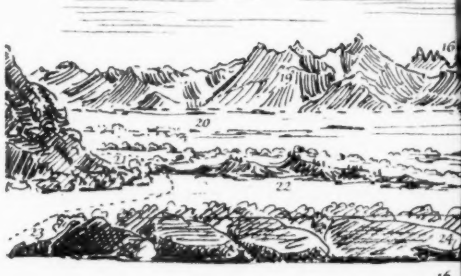
5 Basalt outcrop S.

8. Mount Borauli and ...
desert plain south-east

S.E. 3 Falal valley



7 Mt Assa S.W.
6 Mt Gaddaelo
8 Bodaito W.H.
9 Assa ...
14 Gwia watercourse and camp
15 Northern spur of Datoma Ali...



16 Adangalla
19 Hela Chain
20 Gohoi ...
21 Assa W.H.
22 Basalt hill with tombs
23 Gwia camp
24 Northern spur of D...

11. Panorama south-e...
northern spur of D...

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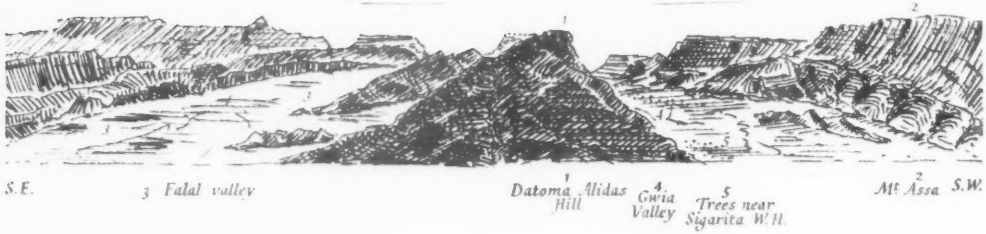
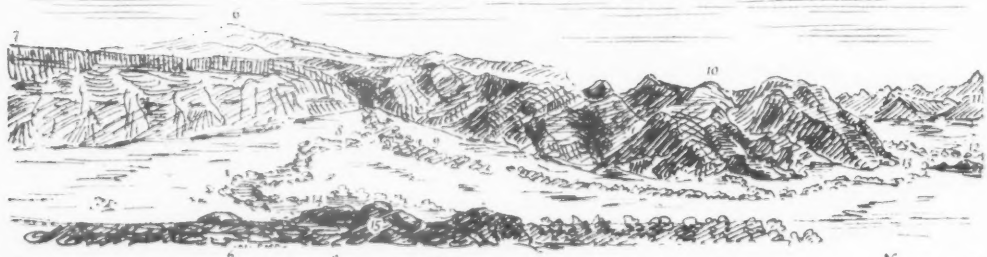
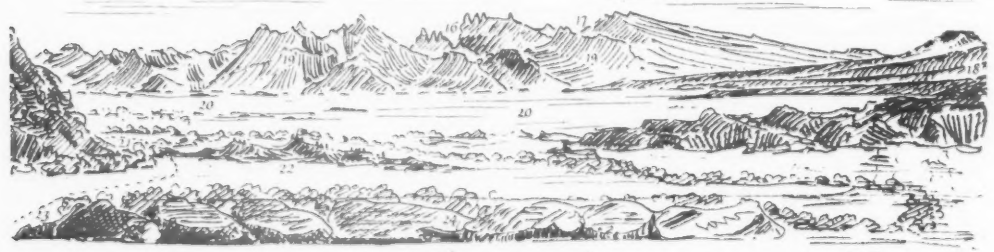
8. *Mount Borauli and view looking south from desert plain south-east of Kulsu Kuma. May 25.*







11. *Panorama south-east to north-east from northern spur of Datoma Alidas Hill. June 3.*

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9. *Mount Iralale from terrace rim above Sekkadahara valley. May 29.*

12. *Panoramas from basalt hill above Galaito Waterhole. June 4.*

STONE POLYGONS BESIDE LOCH LOMOND

PROFESSOR J. W. GREGORY, LL.D., D.SC., F.R.S.

STONE polygons are polygonally arranged bands of flat pebbles, usually surrounding a core of mud, common in Arctic regions in soils composed of mud and stones. They may be associated with curved arcs of stones, each of which is also standing on end. These structures are well known in Spitsbergen, Norway, Iceland, and Antarctica, and have been found in the Alps. Their formation has been discussed in a long and scattered literature. The chief theories of their formation have been clearly summarized in a paper by Professor J. S. Huxley and Dr. N. E. Odell, in this *Journal* (vol. 63, 1924, pp. 207–229). The most widely accepted explanation attributes these structures to the repeated outward push of the pebbles whenever the ground is frozen, and the flow back of the mud during thaw. That theory was advanced by Professor Högbom (*Bull. Geol. Inst. Upsala*, ix, 1908, pp. 41–59) and has been widely adopted, as by Professor Hawkes for a case on a raised beach in Iceland (*Geol. Mag.*, 1924, pp. 509–513, pl. 28) and by Dr. C. S. Elton (*Q.J.G.S.*, vol. 83, 1927, pp. 163–193, pl. 10–12). Nansen (En Ferd til Spitsbergen, 1920 ; Spitsbergen, 1921) on the other hand regarded the polygons as due not to the migration of the pebbles but to the reduction to powder of those in the centre of a group by repeated freezing. This comminution of the stones no doubt takes place to some extent when they consist of soft shale; and both processes are regarded by Huxley and Odell as having shared in the formation of these structures. A modification of the frost-push theory has been advanced by Thoroddsen for the examples in Iceland, where they are known as "rudemarks." His account of the phenomenon, although one of the earliest, has been often overlooked (Thoroddsen, 'The Botany of Iceland,' Pt. I. Physical Geography, 1914, pp. 259–261). He attributed these structures to the combined effect of irregular evaporation from sodden stony clay which has been cracked by frost into clay prisms, and of the pebbles being pushed by repeated frost and thaw into the shrinkage cracks.

My interest in these formations was aroused the day Sir Martin Conway's expedition landed at Green Harbour, Spitsbergen, on 18 June 1896. From the observations made there and at other places in Spitsbergen Professor Garwood and I concluded that these polygons were due to the repeated freezing and thawing of the ground. The stone hexagons appear due to the water freezing into large ice crystals charged with mud and stones, like the sand-charged calcite of the Fontainebleau Sandstone. We did not describe the structures as we expected to find examples of them in the English boulder clays; but to my repeated surprise I have failed to find them in the British glacial drifts, and I am not aware of any definite case of them having been described in glacial deposits, though vertical stones in such are not uncommon. Embryonic frost-formed stone polygons I have frequently observed in recent deposits in Scottish valleys, and I have occasionally seen them well developed, as on the summit of the Merrick (2764 feet), the highest summit in Scotland south of the Highlands (as remarked *Q.J.G.S.*, vol. 83, 1927, p. 193), and on Ben Lawers.

On the southern side of Ross Promontory, the main projection on the eastern side of Loch Lomond, 2 miles south of Rowardennan Hotel and a third of a mile east of Ross Point, is a remarkable development of groups of closely packed tilted stones, similar to the polygons and arcs of the Arctic. Its existence was mentioned in a paper on the Geology of Loch Lomond (*Trans. Geol. Soc. Glasgow*, xviii, 1928, p. 315). The structures are also developed on the shore of a narrow inlet at the eastern end of the slate quarry.

On my first visits to the locality the weather was so wet that photography was impossible; but some photographs were taken by my son during a later visit, due to the kindness of Mr. J. Kirsop, who took us there in his motor boat. The rain soon stopped photography, and Mr. Kirsop kindly made a second visit with my son, who then obtained a further series.

The extensive development of the stone-packing at this locality is due to the frost acting upon a sheet of flat pieces of slate; the beach consists for a couple of hundred yards of waste from the slate-quarry; the fragments range from half an inch, or occasionally less, up to several inches in length; they are in places standing on edge and have been packed into various patterns, some of which are illustrated by the photographs reproduced with this paper. The beach on my first visit had the appearance of an extensive tesselated pavement, for it was then clear of wave-deposited horizontal fragments, which now cover parts of it so that the slate mosaic appears less continuous.

A common type of packing on this beach is around a resistant obstacle as in Pl. 1, where the slates form a frame around an angular boulder of the Lennoxian grits. In some cases the stones have been packed in concentric rings around tree trunks; these examples show that the pressure was not due to the stranding of sheets of lake-ice. In some cases the slates are inclined downward away from the centre (as to the left in Pl. 2), because most of the boulder being buried the pieces of slate slope outward over the top, like slates on the roof of a dome; in other cases (as to the right on the same figure), the pieces of slate slope downward toward the centre. This arrangement may be seen in some places to be due to the pieces having been forced against the under side of a boulder; in some cases the boulder has been removed and the pieces remain around a hollow like the sides of a basket made of cards.

Some of the smaller groups are about 1 foot in diameter. In some cases the packing has been around several adjacent centres forming compound groups, each composed of a series of nests of slate. The largest compound group occupies a roughly oval area about 12 feet long and 5 feet wide; the stones in the centre are irregularly arranged, or are in places grouped around several centres; the area is bounded by a raised band formed of many confluent radial groups (part is shown in Pl. 3); the raised band has a somewhat arcuate or crenate edge.

The beach is traversed by some bands of vertical, parallel pieces of slates, which were probably dry bands, into which the stones were forced from the sides. At the eastern end of the beach there are groups, about 6 feet wide, composed of large vertical pieces of slate; these groups are partly under the water of the lake.

The stone rings on the Ross Promontory, as in Spitsbergen, are very variable in form; for though they have been called polygons from some of the

1. Groups of slate fragments packed round grit boulders (Rule 9 inches long)

2. Slate fragments packed against boulders

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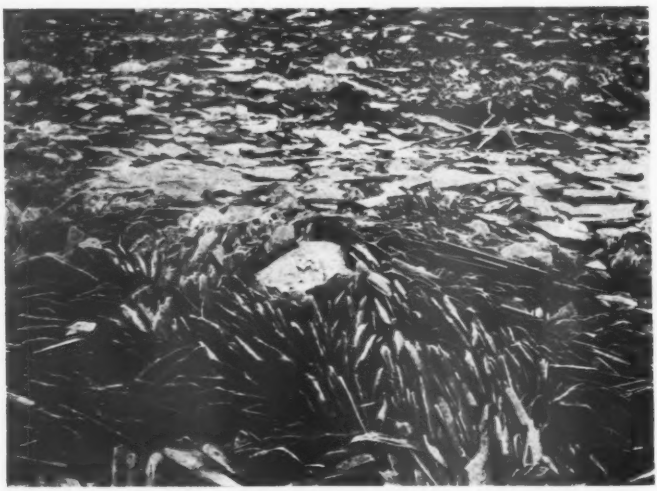
3. Part of a band of composite groups surrounding a large oval depression (Rule 9 inches long)



4. Slate fragments in irregular groups in one case packed round a grit boulder. The band of horizontal fragments is a beach-line

re striking examples, the polygonal form occurs only in a minority of examples. The special feature of the Loch Lomond series is the small amount of fine sediment. The beach consists almost entirely of pieces of slate which is more durable than the shale at Green Harbour, Spitsbergen. The groups consist only of stones without the central core of mud, though in some cases the centre is composed of small fragments of slate. In the absence of fine clay most of the nests of stones are crowded irregularly, with jagged interlocking edges (as in Pl. 4). In some of the groups the slate is arranged radially instead of concentrically. Nevertheless, allowing for the absence of the clay base, the packing of the stones is clearly due to the same process as in the Spitsbergen groups.

Mr. Watson Murray, the Factor to the Duke of Montrose, kindly tells me that the slate quarries were last worked fifty-one years ago. Hence this process has been going on uninterruptedly for half a century.

Two other explanations have been considered. As the beach is exposed to the south-west, ice-floes must be occasionally blown ashore; and it might appear possible that the structures are due to the pressure of stranded ice or the melting of blocks of ice, as has been suggested for some Arctic cases (*Geogr. Journ.*, vol. 83, 1921, pp. 306–9). The packing is however often as well developed on the lee side of boulders and tree trunks as on the side next the shore; hence the grounding of ice-floes cannot be the cause of these structures. Moreover the pressure has not been exerted predominantly at right angles to the lake-shore, as would be expected if it had been due to ice-floes.

The vibration due to waves is also a possible factor, but in the storm beaches, which are well marked at the locality, the pebbles are water-worn and lie horizontally (*cf.* the band across Pl. 4); the arrangement of the materials in the lake beaches presents no resemblance to the vertical or steeply inclined pebbles in the stone-groups. The rings also occur nearby on a sheltered part of the lake shore.

The view that the structures have been formed along shrinkage fissures is also quite inapplicable, though it has been widely attractive and is said to have been the explanation most favoured by visitors to Spitsbergen with the International Geological Congress in 1909.

Polygonal shrinkage fissures in clay are widespread; they have been described by Dr. Smellie from Mesopotamia (*cf.* Huxley and Odell, *op. cit.*, p. 215), and are well developed during the dry season in the clay on the lava plains near Nairobi in Kenya Colony, as the mud of the rainy season shrinks during the dry weather; they may be seen in many places on British roads in the tar macadam, and may then be filled with dust.

The Loch Lomond stone groups are not lines of residual pebbles left after the comminution of the central material by frost as explained by Nansen's theory; for many of them surround hard boulders against which the stones have been thrust and uptilted.

The arrangement of material by the movements in frozen soil varies indefinitely with the special circumstances. The essential factors for stone-packing and the formation of stone-polygons are loose ground containing or composed of flat pebbles; the ground must be sodden with water; and it must be frequently frozen and thawed, so as to be acted on by repeated horizontal

thrusting.* Where the ground, as in Spitsbergen and on the Merrick, contains much clay the stones are pushed outward when the water freezes, and the clay flows slowly back as mud with the thaw.

The Loch Lomond examples of stone-packing and those I have observed elsewhere appear to be adequately explained by the action of frost and thaw. Beside Loch Lomond the pattern varies greatly owing to the extent of the area affected, the absence of clay, the composition of the beach of fragments of slate, the presence of the numerous boulders and trees, and the irregular distribution of water in the beach. The nearly vertical attitude of the stones shows that the main pressure was horizontal; in some cases the push was outward from the centre of the group, and in other cases where the ground contained less water the push has been toward the centre of the group, and the packing has been around a resistant obstacle. But allowing for the various local circumstances that modify the directions of movements during the freezing of a waterlogged stone-charged layer, the tesselated pavement on Ross Point, and similar Arctic structures appear explicable by the movements due to repeated freezing and thawing. These structures are an example of the solifluction processes due to frost.

*I have recently received from Mr. J. Selwyn Turner, F.G.S. (11 September 1930), some photographs of similar stone rings which occur between tide marks in the debris from an old slate quarry at the mouth of the Coomhoola river, at the head of Bantry Bay, South-West Ireland. At this locality, as Mr. Turner remarks, the action of frost must be negligible. He attributes them to " the packing action of the advancing and retreating waves, aided to some extent by gravity." This case shows that the packing may be due to different causes.

THE EAST GREENLAND PACK-ICE AND THE SIGNIFICANCE OF ITS DERIVED SHELLS

V. E. FUCHS AND W. F. WHITTARD

THE summer of 1929 was extremely unfavourable for navigation in the East Greenland pack-ice. Adverse conditions kept the ice pressed against the coast, and lanes or leads of water along which a ship might have passed were rarely found (Plate 3). The Cambridge Expedition was thus detained among the ice-floes for four weeks. During this time it was noticed that in many cases fine mud rested upon the irregular surface of the ice. A more careful examination was then made of mud on other floes, and finally Dr. J. F. Varley obtained a number of shells.* The object of this paper is to show how shallow-water shells associated with clays may be transported by ice for several hundred miles, and to emphasize the possible bearing of this fact upon the question of the origin of certain Pleistocene glacial clays containing derived shells.

The Pack-Ice

The wide belt of ice which drifts down the east coast of Greenland as far as Cape Farewell, and which averages in summer about 80 miles in breadth, originates from within the Polar Basin. A threefold division of the belt can be recognized, the different zones arising through the complexity of the currents operating within the Greenland and Barents Seas and the Polar Basin. The supply of water to the Polar Basin is almost restricted to that from the Greenland and Barents Seas, there being little circulation through the Bering Straits or from Baffin Bay. After impinging on the coast of Great Britain, the North Atlantic Drift passes along the coast of Norway towards Spitsbergen, where it divides into a westerly and an easterly branch.

The westerly branch of the North Atlantic Drift carries the Spitsbergen ice westwards until it reaches the pack-ice off East Greenland and forms the Outer Zone. On entering the pack from the east, therefore, a ship first passes through the so-called "Spitsbergen ice," which is not more than two years old, small, easily breakable, and comparatively salt (Plate 2).

The easterly branch of the North Atlantic Drift sweeps along the North Siberian coast past Cape Chelyuskin, and, as Nansen's voyage in the *Fram* has shown,† the movement of the ice is then across the Polar Basin, and thence down the East Greenland coast; the ice is made of polar floes which occur in fields up to 200 square miles in area; this ice forms the important Middle Zone. A considerable proportion of the ice has certainly originated near the North Siberian coast and is evidently three to five years old; it is extremely massive, thick, and practically devoid of salt.‡ The polar ice carries pools of water, and

*Wordie, J. M., *Geographical Journal*, vol. 75, 1930, p. 483.

†Nansen, F., 'Farthest North,' 2 vols. London, 1897.

‡Although not strictly pertinent to the subject herein considered, it is worth recording the existence of freshwater and marine faunas in the water upon which the pack floats. Many excursions over the ice enabled the members of the Cambridge Expedition to examine the animal-life, and on one occasion numerous specimens of a brilliantly coloured crustacean (Branchiopod) were collected. These were placed in a bowl of salt sea-water, and within a minute all were dead. On further investigation

has the general appearance of a "worn-down oldland" traversed by pressure ridges, which sometimes rise from 15 to 20 feet above the sea-level (Plate 1). It was only upon the polar ice that the mud with shells was found.

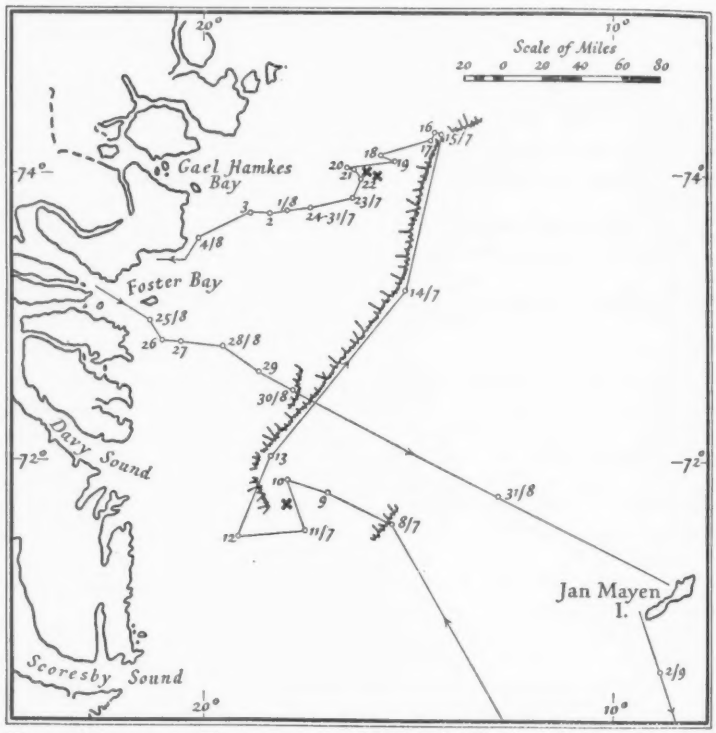


Fig. 1. Diagram to illustrate route of "Heimland" through East Greenland pack-ice. Small circles denote daily positions of vessel and crosses positions of mud in which shells were found. Mud without shells generally present in Middle Zone of pack-ice

The Inner Zone of the pack-ice is occupied by land floes, originally formed as landfast ice on the freezing of the coast water during the previous winter;

it was discovered that the crustaceans did not frequent the lower layers of the sea (containing *Euphausia* and other crustaceans, Nereids, and Ctenophores such as *Beroë*) and that they were freshwater animals. Presumably the freshwater forms are carried along by the current and the pack, the freshwater being constantly supplied by the melting of the massive polar ice. Owing to the damping by the pack-ice of any oscillations due to wave action, a stratum of freshwater is maintained. Thus a freshwater fauna can exist side by side with a marine fauna, and this anomaly is intensified when it is realized that when the ice melts entirely, the animals are killed in great numbers. Not only might a freshwater fauna become associated with a marine fauna in deposition, but boreal species might well occur with forms characteristic of more temperate regions.—*W.F.W.*

this ice does not present the same hindrances to navigation as the polar ice of the Middle Zone.

The whole of the pack-ice is constantly moving southwards at a speed varying from 5 to 20 miles a day. The variation in speed depends on the southerly drift of the East Greenland current, on the velocity of the winds, and on the distance from the mainland. Thus on an average 800 square miles of ice pass any particular locality on the land in one day in summer; this figure is sufficient to show how great a quantity of mud must be discharged into the sea when the ice melts, although the mud is restricted to the upper layers of the ice and is not found on every floe. How far the mud is transported after the ice melts is difficult to decide, but the very fact that the East Greenland current turns northward round Cape Farewell suggests that conditions here favour rapid deposition.

Occurrences of Mud with Shells upon the Pack-Ice

Mud without shells was noticed on ice in the Kara Sea by A. E. Nordenskiöld on the occasion of the Swedish Expedition to the Yenesei in 1875*: Nansen made collections in 1885 from the pack-ice off the coast of East Greenland,† and again between 1893 and 1896 from polar ice in which the *Fram* was imprisoned‡: Nathorst obtained samples in 1899 from "Spitsbergen ice" on the eastern edge of the pack;§ and the recent discovery on White Island of Andrée's diary and specimens shows that he collected from the ice "20 samples of clay, gravel, moss, leaves, and driftwood."‖ The only occasions known to the authors when shells, in addition to mud, have been collected are those recorded by Gray, whose father discovered shelly muds on the East Greenland pack-ice in 1876 and 1879,¶ by Stappers, who described examples from the Kara Sea where the material was evidently similar to that seen last summer,** and by De Long, who made frequent references in his Journal to shelly muds, which he noticed on ice in the Polar Basin, when drifting in the *Jeannette*.†† In 1916 Stefansson found "mud, gravel, slate and boulders, the largest weighing over a hundred pounds," on ice in the Peary Channel (Parry Islands), and attributed their presence to "a landslide descending on ice lying near a precipitous coast"; he also records great numbers of shells which were heaped upon pressure ridges.‡‡

*Nordenskiöld, A. E., 'Svenska färden till Novaja Semlja och mynningen af Jennisej sommaren 1875.' Gothenburg, 1875.

†Gran, H. H., 'The Norwegian North Polar Expedition, 1893–1896.' Scientific Results, vol. iv, no. xi, 1904. "Diatomaceae from the ice-floes and plankton from the Arctic Ocean."

‡Bøggild, O. B., 'The Norwegian North Polar Expedition, 1893–1896.' Scientific Results, vol. v, no. xiv, pp. 50–52, 1906. "On the Bottom Deposits of the North Polar Sea."

§Nathorst, A. G., "Den svenska expeditionen till nordöstra Grönland in 1899," *Ymer*, 1900, p. 124.

‖*The Times*, 20 September 1930, p. 10.

¶Gray, R. W., "Ice-bergs in a High Latitude," *Nature*, vol. 124, 1929, p. 479.

**Stappers, L., 'La Ravanche de la Banquise,' by the Duke of Orléans. Paris, 1909. Appendix 4, v. "Dépots Minéraux sur les Glaces de la Mer de Kara," p. 268.

††De Long, G. W., 'The Voyage of the *Jeannette*.' Ed. by Emma De Long, 2 vols. 1883.

‡‡Stefansson, V., 'The Friendly Arctic,' 1921, pp. 513–516.

Elsewhere in the Arctic and Antarctic shallow-water shells have been described associated with boulder clays formed through the mechanism of glacier ice; although their origin is different from that of the pack-ice shelly muds, it is necessary to refer briefly to some of the occurrences. Lamplugh, for example, observed englacial shelly boulder clay which had been ploughed up from the sea-floor by the Sefström Glacier in Spitsbergen*, and Debenham and others collected a large fauna at McMurdo Sound (Antarctica) from raised marine muds.†

The shell-bearing mud examined last summer characterized the Middle Zone of the pack-ice (Fig. 1). A section taken through a mud region would show an upper band of coarsely crystalline ice representing falls of snow, underlain by a dirt layer with or without shells, resting upon massive blue ice. The mud is pale greyish-brown in colour, fine grained, and occasionally yields small well-rounded pebbles, sometimes with attached hydrozoa. Frequently it is found at the bottom of freshwater pools in small hollows, which are caused by the thawing properties of the mud. The following fauna and flora were obtained:—Lamellibranchiata: *Astarte borealis*, Chemnitz; *Cyrtodaria siliqua*, Lamarck; *Lyonsia gibbosa*, Hancock; *Modiolaria discors* (L.), var. *substriata*, Gray; *Modiolaria nigra* (Gray); *Mytilus edulis*, L.; *Portlandia glacialis* (Leach); *Serripes groenlandicus* (Gmelin). Gastropoda: *Amauropsis islandica* (Gmelin); *Natica affinis* (Gmelin); *Sipho togatus* (Mörch). Spongida; Bryozoa; Hydrozoa; Algae; and pieces of wood.

Mr. Tomlin has kindly identified the shells, and his notes on their distribution show that the distinctive forms have come from many different localities within the Arctic. This accords with the fact that the material of the polar ice is also derived from many sources. The presence of small pieces of pine wood in the mud and the abundance of logs of Siberian fir and pine on the coasts of East Greenland, Iceland, and Jan Mayen Island also bear testimony to the course of both the polar ice and the East Greenland current (Plate 4). Marine diatoms and algae frequently occur in the ice; Gran, when dealing with the distribution of species, came to the conclusion that the forms were probably derived from several parts of the Arctic, although there was evidence which suggested that many were derived from near Cape Wankarema, north-west of Bering Straits.‡ On rare occasions freshwater diatoms have been collected.§

Theories of the Origin of Shell-bearing Glacial Deposits of Pleistocene Age.

There seems little doubt that the formation of certain shelly boulder clays must be attributed to the action of glaciers which advanced over the sea-bed, and in their course picked up shells, mud, and boulders. These were subsequently transported to higher levels on land, and stranded through the melting and retreat of the ice. An example on a small scale of such a phenomenon was examined by Lamplugh in the Sefström Glacier, Spitsbergen.‖

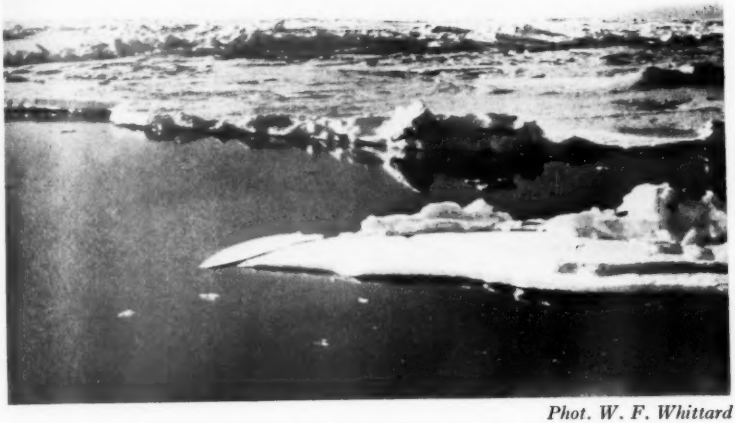
*Lamplugh, G. W., *Proc. York. Geol. Soc.*, vol. 17, 1911, p. 235.

†Debenham, F., *Q.J.G.S.*, vol. 75, 1919, pp. 51–73.

‡Gran, H. H. *op. cit., supra.*

§Cleve, P. T., "Diatoms from Franz Josef Land collected by the Jackson-Harmsworth Expedition in 1898." *Bih. till K. Svenska Vet.-Akad. Handl.*, vol. 24, 1898, no. 2.

‖Lamplugh, G. W., *op. cit., supra.*



Phot. W. F. Whittard

1. Large field of polar ice with many pressure ridges

2. Floes of "Spitsbergen ice" *Phot. V. E. Fuchs*

UNIV. OF MICH.

Phot. R. C. Wakefield

3. Lane or lead of water in polar ice blocked by small floe

Phot. M. M. L. Parkinson

4. Drifted logs of Siberian pine and fir cast up on Jan Mayen Island, North Lagoon

Debenham has advanced an explanation of the presence of organic remains in raised marine muds lying on glacier ice at McMurdo Sound, Antarctica.* The organisms are associated with sodium sulphate (mirabilite), salt, and boulders, and according to Debenham these reach their position by vertical transport through the ice. He considers that the base of the ice-sheet resting upon stagnant water increases by freezing below, and picks up the organisms and sediment from the sea floor. Where débris occurs on top of the ice it "increases the thaw in the summer to an enormous extent," and there is a net decrease of the ice from the top of about 1 foot in four years. The organic remains and sediment thus work upwards through the ice, and eventually reach the top, where they form the raised marine beds. It is only on sheet ice covered by débris that thawing is so important, because it "reverses the order of things as found on the Barrier, where there is an annual increase by snowfall." Material could work upwards when surface thawing and ablation was equal to, or less than accretion from below. Debenham has suggested that perhaps some of the Pleistocene shelly deposits were formed by the melting of the glacier ice carrying raised marine muds, followed by the return of the material to the sea floor. Such a theory formulated for the origin of certain shelly deposits in the Antarctic is hardly tenable for the shelly muds found on the Arctic pack-ice, because not only does the strong polar current tend to prevent the complete freezing of the sea, but also if the shells in the polar ice worked upwards to the surface, then bands of dirt should have been noticed within the massive ice. This was never the case in the numerous ice-floes examined last summer, and no mirabilite, salt, or boulders were seen.

More than fifty years ago Shone suggested that shells in boulder clays had been carried on ice-rafts.†

"In the early part of 1875 there was a short, but for the time a very severe frost. At the mouth of the Dee there is an island called Hilbre, some five acres in extent; it is distant across the sands about a mile and a half from the Cheshire shore; this space is covered with water at half-tide. The dead shells of Mollusca, Ostracoda, Foraminifera, etc., which live in the Laminarian zone are cast up and left by the receding tide between the ripple-marks on the sands. The dead shells of the Gastropoda, as they lie in these hollows, get more or less filled with the fine silt containing the Microzoa. The frost was severe enough to freeze the water left in these furrows by the receding tide; consequently the Gastropoda filled with this silt, the broken shells, etc., were enclosed in thin sheets of ice, which were broken up on the return of the tide, and such as were cast ashore on Hilbre Island were piled together and frozen into blocks. When the thaw commenced it set these blocks free. Charged with the Gastropoda and broken shells, these tiny ice-rafts floated short distances away, distributing as they melted their load of broken shells, and casting the silt-filled Gastropoda over the mud-flats of the delta of the Dee."

It is evident that if the small ice-rafts of Shone are enlarged to huge ice-fields, carrying large quantities of sediment not merely across an estuary but across an ocean, then Shone's theory provides a mechanism by which some shelly boulder clays may have been formed.

*Debenham, F., *op. cit., supra*.
†Shone, W., *Q.J.G.S.*, vol. 34, 1878, pp. 383–397.

Origin of the Shelly Muds on the East Greenland Pack-ice and their Relation to certain Pleistocene Shelly Deposits

There is evidence which suggests that the solution of the problem of the mode of conveyance of the shelly muds upon the ice is closely connected with the seasonal climatic variations of the North Siberian coast, and with the rivers which drain into the Polar Basin in that region.* The rivers derive most of their water from the melting of the southern snow during the months of May, June, and July, when they overflow their banks, spread over the gently sloping muddy coast, and pick up shells, which are carried out over the ice along with the shore and river mud. During the floods the River Lena spreads to a breadth of 60 miles or more, when "monstrous blocks of ice as large as small cottages lay stranded ashore, and the water" rises in places "to a height of 40 feet, as indicated by the drift-wood lodged in trees, thousands of which" are "torn up by the roots or hurled flat by the overrunning ice, and swept out to sea." The large blocks of ice often form dams across the river, and "when an ice-dam breaks a vertical wall and flood of water will rush down the river for miles . . ., carrying everything before it, until it vanishes in the many outlets and seeks the sea." "As the season advances, the waters decline in volume, and during the month of August the river rapidly subsides, until by the first of September it is flowing at low ebb. This is the period at which all melting ceases and the young ice begins to form, and as the process goes on, the water which bore the ice on its bosom falls away for want of further supply from the south, and the great sheet of ice . . . tumbles in, and is carried away by the swift, unchanging current. . . . Then the ice grinds, swirls, and piles upward, while the river rises . . . and drives the ice before it . . . ; and these freezings and floods continue until late in autumn." In mid-winter the ice is again frequently flooded, due to the "hydraulic pressure up stream, which raises the ice-bed and finally bursts it open; and the water continues to overflow until the pressure is relieved, when it freezes in again."

The flood waters in early summer and mid-winter deposit some of their mud upon the ice, along with shells and pebbles picked up from the shore. Later, at the end of winter, the ice breaks up, and, under the influence of winds and flooded rivers, it is swept out with its load of mud and shells, and is eventually consolidated with other ice-floes to form ice-fields. These ice-fields are carried by the North Atlantic Drift into the Polar Basin, which they leave as part of the East Greenland pack-ice. The amount of snow which falls during the year is approximately counterbalanced by ablation and thawing during the summer, with the result that the mud remains at the top of the ice either uncovered or covered by a thin layer of recrystallized snow.

Mr. Stefansson has suggested that some of the mud and shells may have been carried upon the ice by wind.† Bounding Franklin Bay (North Canada)

*The following account is based upon observations made by Melville (Melville, G. W., 'In the Lena Delta,' 1885, pp. 384, 301, 146, and 264); by Wrangell (Wrangell, F. von, 'Narrative of an Expedition to the Polar Sea,' 1840, pp. 393, 221, and 63); and by Nordenskiöld (Nordenskiöld, A. E., 'The Voyage of the *Vega* round Asia and Europe,' vol. 1, 1881, p. 189).

†The conditions in Franklin Bay have been described verbally by Mr. Stefansson to the authors.

there is a plateau region between 1000 and 2000 feet above the sea-level, which terminates in a steep cliff, separated from the sea by a gently inclined coastal region up to 3 miles in breadth. In certain years, warm southerly winds prevail in the late summer, and although the mainland is extremely cold, the water in the bay remains unfrozen. Ice forms however as a coastal fringe and may extend as much as 4 miles out to sea. The warm air above the bay rises up the steep cliff, and cold air sinks down from the mainland to take its place, and in effect forms a "Niagara of wind," which blows with the intensity of a gale. The wind is sufficiently strong to carry large pieces of slate and other rocks, which are tumbled down the cliff, are rolled out towards the sea, and some come to rest upon the ice fringe. As autumn progresses, the southerly wind ceases and strong winds blow from the north-west. Immediately the water in the bay freezes over, and as there is no longer a great difference in temperature between the air over the land and sea, the gale from the land stops. With the approach of spring, the ice in the bay breaks up, and drifts out to sea, carrying a load of wind-transported material. With regard to the shell-bearing muds on the East Greenland pack-ice, wind action may have been responsible for the transport of some of the material since intermittent southerly gales sweep across North Siberia throughout the year,* but it seems more probable that the transport of fine-grained muds with their unbroken shells and rare small pebbles is more reasonably attributed to the action of fast-flowing rivers flooding the ice with water which was charged with mud and shells.

As a result of last summer's observations, we consider that some shelly clays of Pleistocene age may have been formed by deposition from a field of sea-ice, such as the East Greenland pack-ice, which acted as a carrier, and possibly transported the material many miles from its source before depositing it on the sea-floor (Plate 4). This pack-ice hypothesis, which is regional in its application, would account for the great areal distribution of certain clays of Pleistocene age. Further, the anomalous occurrence of mixed faunas in glacial beds is explained by the melting of a sea of ice which has travelled a great distance and deposited its mud and shells; these become intermingled with the indigenous fauna of the region, which, besides being different in species, may also belong to a different zoological province. On the facts recorded in this paper, therefore, it seems that some of the Pleistocene shelly deposits may have reached their present position by transport on pack-ice. The height above sea-level of any British deposit, the presence of which could be explained by pack-ice carriage, necessitates an elevation of the land during or after the Glacial Period.

Our thanks are due to Mr. J. M. Wordie and other members of the Expedition, to Professor W. W. Watts, and to Mr. Vilhjalmur Stefansson, for their valuable assistance. One of us (W. F. Whittard) is indebted to the Commissioners for the Exhibition of 1851 for permitting him to devote time to a different research from that for which the Studentship was granted, and to the Royal Society for the award of a Government Grant.

*Melville, G. W., *op. cit., supra*, p. 299.

THE BRITISH ARCTIC AIR ROUTE EXPEDITION

THE brief and modest reports which have been sent by Mr. Watkins to *The Times* give us the excellent news that all has gone well with the expedition which sailed in the *Quest* for East Greenland on July 6. They have established their base near Angmagsalik and an observation post on the centre of the ice-cap at about 7000 feet in lat. 65° 38′ N., long. 38° 38′ W.; they have made great progress with the air survey of the eastern coast, and have already more than proved the importance of the expedition to the end in view by discovering a considerable range of mountains higher than anything previously known in Greenland.

An interesting batch of letters from Mr. Watkins and several of his companions has come out with the last ship of the season, and we take leave to print the letter of the leader to the Secretary of the Society.

S.S. Quest, Kangerdlugsuak, East Greenland, 25 August 1930

We have placed our base east of Angmagsalik Island on the mainland lat. N. 65° 38′ 22″, long. W. 38° 38′ 16″. Here we found a place where it is moderately easy to get on to the ice-cap. It took us about two weeks to build our house and get all our stores ashore. On August 11 Scott, Rymill, Bingham, Riley, and Lindsay set off with four teams of a dozen dogs to put up a station 140 miles in on the ice-cap (this should be its highest point in this latitude according to de Quervain). Riley and Lindsay will be left at this station for two months. Scott's party should get back to the base about September 1.

On August 12 Lemon was left at the base and the rest of us started north in the *Quest* in order to survey the coastal belt north of Angmagsalik. We have been extraordinarily lucky with regard to ice conditions as we have come without very much difficulty to Kangerdlugsuak Fiord. This fiord is about 7 miles wide all the way up, and I should say it is between 30 and 40 miles long, but this is a guess as we are only just starting to survey it. Several glaciers come down into it and a very large one comes down into the head of the fiord. The whole of the end of this glacier is floating. We are starting the survey here and gradually working back to our base. We had hoped to go farther north, but it is getting too late, as even now some of the bays freeze over at night. Anyhow I hope to get the northern part done in the spring. On the way up the coast we have been flying whenever possible to take survey photographs to assist the ground surveyors. I have been doing the photography. It is a weary job, as one has to take a photograph every thirty seconds for about one and a half hours at a time, and the thirty seconds do not leave much time for changing the plate, etc. However we are managing all right. Our system is as follows: The *Quest* finds a suitable place for the plane to take off; such places are few and far between owing to the drift-ice. We then take off and climb to 10,500 feet. After that we fly along the coast-line for about one and a half hours, taking vertical photographs of the edge of the coast. We do not fly on a compass course, but follow all the ins and outs of the coast. The time interval allows about 65 per cent. overlap on the photographs. On the return journey we take oblique photographs, which take in the coast-line and the mountains, back to the ice-cap. So far we have photographed in this way from our base to Aggas Island, which is about 70 miles south of Kangerdlugsuak.

We are now waiting for suitable conditions to complete the photography

from there up to here. When that is done D'Aeth and I will fly back to our base and leave the ground party to carry on. They will gradually work down the coast in the *Quest* until September 15, when the *Quest* will have to leave owing to lack of money. The party will then continue down the coast in the motor boat and should arrive at the base about September 30. This party consists of Courtauld, Stephenson, Wager, and Chapman.

When D'Aeth and I fly back to the base we shall wait for Scott's party to arrive (this will probably reach the base at the same time as us) and then we shall start on the southern journey. On this journey we hope to go up on to the ice-cap and turn south, and then follow the ice-cap as far south as time allows. We shall then turn north and follow up the centre of the ice-cap to our centre station. We hope to get the height all along the ice-cap on this journey. We should certainly be able to get down to the point where Nansen crossed and possibly beyond. The main party on this journey will consist of Scott and myself. We hope to be away two months. For the first fortnight we shall have a supporting party consisting of D'Aeth and Bingham. I am afraid it will be a cold journey as it is late in the year. We are very sad to find that the dogs refuse to be driven in the single-trace method. As we have not yet had time to train them we shall have to use the fan method on our first journey, and it is not nearly so efficient.

Flying conditions over the ice-cap and near Angmagsalik are really ideal. We have only had two days when it was not possible to fly. However the coast-flying north of Angmagsalik has been a very different affair owing to the heavy drift-ice which packs in against this coast. It is almost impossible to find a place where there is sufficient open water to take off, and having taken off the ice may close in again and it may be impossible to land! After a great deal of difficulty we managed to find a lake about halfway between Angmagsalik and here. This lake was about 1½ miles from the sea and had no ice on it. After nine attempts in rather dangerous ice we managed to get the seaplane off the sea and landed it on the lake. All the coast photography has been done from this lake. However the flying is not at all pleasant, as if the engine failed anywhere except over the lake a forced landing would certainly end in disaster as the sea-ice is too thick to land in.

From this lake our plane had not got sufficient range to photograph north of Aggas Island, so that we are now vainly searching for a place to take off here so that we can complete the survey. When we get back to the base we shall put the plane away until the winter and then we shall have both our planes on skis. Winter flying is going to be a good deal safer than this summer flying. Danger would be practically non-existent if one had two- or three-engined machines.

I have been frightfully lucky in the men whom I have got with me. They are all excellent, and judging by the amount of work they do the expedition should be successful.

Aug. 31—Since writing the above we have been delayed by bad ice conditions, and to-day have just completed our aerial photography. While flying to-day we saw a large range of high mountains about 30 or 40 miles north of here. We were flying at 10,500 feet and the mountains were almost certainly about 4000 feet higher. We have no time at the moment to do anything about this discovery or even to find their height, but we shall try and get to them in the spring by sledge.

THE FATE OF ANDRÉE

THE fate of Andrée's balloon expedition towards the Pole has after thirty-three years been ascertained, though it is not yet possible to base any critical account upon the voluminous but not very consistent statements telegraphed from Tromsö and published by the newspapers in extraordinary detail. It will be better to wait for the official report of the mixed Commission now studying the diaries and relics found with the remains so long preserved in the ice on Kvito, and this year revealed to the enterprise of Norwegian scientific and hunting parties by the grace of an exceptionally open season. We know that the balloon came down after several days of travel made intensely trying by the shocks transmitted through the trailing guide-rope. We know that the small party marched and drifted, not badly supplied; that they landed and camped on Kvito, and that they perished by sickness or by accident before their supplies were exhausted. One diary is legible, the second in a very delicate and perhaps hopeless condition. The report of the Commission and the careful publication of what can be deciphered from the diaries will be awaited with great interest.

The remains of the three adventurous travellers, thus unexpectedly recovered, were brought back to Stockholm with every mark of respect and sympathy, escorted by warships and aeroplanes and saluted on their passage down the coast of Norway and the Sound by the representatives of all Scandinavia. Thanks to the good offices of the Secretary of State for Foreign Affairs and of the British Minister in Stockholm this Society was enabled to pay a last tribute of respect to the explorer with whom it had been to some extent associated in preparing the enterprise. One of the staff of the Legation in Stockholm represented the Society at the solemn reception of the remains, and laid a wreath upon the bier.

The following recollections of Andrée's visit to London in 1895 have been contributed by Mr. Reeves:

It may be of interest to call to mind Andrée's visit to this country and our Society when making preparations for his hazardous flight which ended so tragically. This was in the summer of 1895 when the Sixth International Geographical Congress was meeting in London, for the arrangements of which the Society was responsible. The meetings were held at the then newly erected Imperial Institute, and it was at one of these that Andreé gave an account of the plans for his expedition. The probable climatic conditions to be met with, the construction of the balloon, the arrangements for steering it, the equipment, and other details were described by him in the paper he then read, which is given in full in the Report of the Congress published in 1896.* In the light of recent events this paper is especially interesting, and well worth reading. Unbounded confidence in the scheme marks it throughout, and whatever may have been thought of the chances of his success by those who listened to it, all were impressed by the pluck and daring of the man who would venture on such an enterprise and face such tremendous risks. In the discussion of his paper that followed Andrée certainly did not get much encouragement for his

*"A Plan to reach the North Pole by Balloon." By S. A. Andrée. Report of the Sixth International Geographical Congress held in London 1895 (London 1896), pp. 211–227.

scheme, but his answer was, "I have got the money, and the attempt will be made."

During his stay in London Andrée frequently visited the Society's house at 1 Savile Row, and everything was done to assist him by members of the staff. He was often in the Map Room consulting polar charts, and was especially desirous of finding out what instruments would be most suitable for him to take on his expedition. In this Mr. J. Coles, late R.N., then Map Curator and Instructor in Surveying, was able to give valuable advice, and made many useful suggestions. One of Andrée's difficulties was to find some instrument that would enable him to take reliable altitudes of the sun from the balloon when the natural horizon was invisible, and, owing to movement, an ordinary artificial horizon would be useless. It so happened that I, then Assistant Map Curator, was experimenting with an instrument I had designed for such purposes, and Andrée inspected the first model of this made. He was very pleased with the instrument and decided to take one with him. It would be interesting to ascertain if this is among the relics of the expedition recently brought back to Sweden.

Andrée's hope, of course, was that the balloon would be carried across the Polar regions and come down somewhere on the American or Siberian side. But supposing this to be the case there was the danger of his being killed by natives from fear and superstition; so large numbers of a leaflet were printed with a representation of the balloon upon it, stating that if any one saw an object like that coming over in the sky they were not to think that there was anything devilish about it, or that it was something that would do them harm, as it contained only men sailing in a ship in the air just as ordinary boats go on the water. It also asked that assistance should be given to the men in the balloon, and that its arrival should be reported as soon as possible at the nearest civilized station. At the request of the Swedish Government arrangements were made to have these leaflets distributed. The Hudson's Bay Co., and others who had the power to do so, were asked to do what they could in the matter. The Society took a great interest in this as well, and some must remember seeing this leaflet and being much impressed by its quaint wording.

REVIEWS

RAMBLES IN DEVON. By J. H. WADE. *London: Methuen & Co.* 1930. 8×5 *inches;* xiv+272 *pages; illustrations and map.* 7*s* 6*d*

The author, who has already written on Somerset and Cornwall, has written this interesting and informing book of Rambles in Devon, "to complete the triology" (*sic*). In an introduction and twenty-three chapters dealing with districts, he covers in his descriptions a great many places, and naturally does not often linger over details. He has walked the county and his pages reap some of the advantages of his method: he writes not for Devonshire people, but for the stranger within their gates. He writes well and has obviously been at great pains to get up the lore, but he suffers from a *cacoethes citandi*, a tiresome habit of excessive quotation. For pages together there is scarcely a sentence without quotation marks, and many of the passages cited are not particularly apt or in themselves striking. The pages contain several misprints, *e.g.* limped (=limpid), p. 29, Launcester (=Launceston), p. 258, the Valley at (=of) the Culm, Contents. The photographs illustrating the text are adequate; some have the merit of presenting an unusual point of view. S. E. W.

THROUGH THE KENNET AND AVON CANAL BY MOTOR BOAT. By C. HERBERT SMITH. *London: George Roberts* 1929. 7×5 *inches;* xii+78 *pages.* 3*s* 6*d*

It is surprising to find that this canal is still navigable, even through the Savernake tunnel at summit-level, by a 20-foot motor boat. The great Sapperton tunnel on the Thames and Severn Canal has had no water in it for several years. We are told nothing of traffic met on this trip; but it looks as if barges could not make the through journey now, even though the locks, including the famous staircase of twenty-nine at Devizes, are workable and a certain number of lock-keepers are employed. This little book is mainly a record, told in English so bad as to be almost comic, of passing through endless locks and of battling with masses of weed ("which when once it hits the propeller you are finished"). Owing to these two causes progress was so slow and required the output of so much physical effort that the game seems to have been hardly worth the candle; we suggest to the author that less energy would be expended in towing, poling, and paddling a punt or skiff and that these little waterways should be navigated only in the spring. The scenery of the Kennet valley is not considered worthy of much remark; but the author "feels sure that when the Creator made the valley of the Avon from Bradford to Bathampton He intended it for the use only of the river and the canal," *i.e.* not for railway trains but for motor boats. J. H. R.

SUFFOLK. By LILIAN J. REDSTONE. With an Introduction by W. E. JORDAN. (The Borzoi County Histories.) *London: Alfred A. Knopf* 1930. 8×5 *inches;* 110 *pages; illustrations and maps.* 3*s* 6*d*

This little volume forms one of a series of county histories which are in many ways excellent companion volumes to the county geographies published by the Cambridge University Press. Miss Redstone has made a success of the present volume: she obviously knows her Suffolk well, and as she notes in her preface, she has always been able to draw on her father's vast store of knowledge in all subjects pertaining to the county.

The volume is written in a simple style and a great deal of interesting information is contained in it. Suffolk has never been in the place of greatest moment in our history, but has held the position of an ordinary man fulfilling his duty in a quiet and efficient manner. There have been dramatic incidents, but "The thing

that has counted most is not these dramatic moments, but the everyday life which has gone on continuously between them. Communal life in village groups, where men lived on an equality, and dependence on a feudal lord was slight; the tilling of numerous small farmsteads; the growth of sheep-farms, and the development of the wool trade; the building of fine churches, the long struggle of a Puritan people for the teaching of the Gospel as they understood it; the establishment of many trades with distant countries to replace the vanished woollen industry—such things as these have distinguished Suffolk history and are doing so still."

The publication of a volume such as this is always welcome: the "ordinary" in history cannot be dealt with in general books, and those interested in particular parts of Britain will find in these volumes a succinct and readable account of the development of the county in which they are interested. A short glossary of place-names is added, based mainly on Skeat's work: Miss Redstone notes that further research may lead to conclusions different from those of this authority. There is also an index. It is perhaps a pity that short bibliographies are not given at the conclusion of each chapter, the more so as the scheme of the book is chronological. J. A. S.

THE *ANNIE MARBLE* IN GERMANY. By C. S. FORESTER. *London: John Lane, The Bodley Head* 1930. 8×5 *inches;* vi+312 *pages; illustrations and maps.* 8*s* 6*d*

We have been previously introduced to the *Annie Marble*, a 15-foot punt-built dinghy with outboard engine (see *Journal*, 74, 1929, p. 485); on this occasion Mr. Forester relates his further adventures on the rivers and lakes of Germany. He has the happy knack of making even the commonplace sound interesting, and the book is an engaging and humorous record of the 1000-mile voyage. The route chosen was from Hamburg up the Elbe as far as Magdeburg, thence by the Ihler and Plauesche Canals to the Potsdam Lakes; a return was then made by the Havel and Elbe to the Elde, and the Mecklenburg Lakes were visited; the voyage concluded at Stettin, reached by the Hohenzollern Canal and the Oder. Incidentally, the book gives a good picture of the vast system of waterways in inner Germany. Geographically, the chief interest lies in the little-known but beautiful Mecklenburg Lakes, through all of which the *Annie Marble* journeyed. They appear to be ideal for a tour of this kind, and possibly there may be some adventurers who will wish to imitate Mr. Forester. If so they will find in this book much useful information. It can also be safely recommended for an enjoyable evening's entertainment. A. W. S.

RUMANIA'S NEW ECONOMIC POLICY. By VIRGIL MADGEARU. *London: P. S. King & Son* 1930. 9×6 *inches;* x+64 *pages.* 5*s*

This book may be regarded as authoritative, since it was written by the present Minister of Finance, who was responsible for most of the legislation described within it.

The interest of the book to the geographer will probably lie mainly in the fact that the present Romanian administration has recognized the geographical limitations of the country as regards the establishment of large-scale manufacturing industries, and has decided to devote its attention to fostering the country's natural agricultural advantages. In a world where almost every nation seems to be aiming at economic self-sufficiency, the abandonment of a high protective tariff on manufactured goods may appear somewhat surprising, but it had become quite evident that industrialization was being attempted at the expense of the agricultural majority. Moreover, even with the constant raising of the tariff wall,

and subsequent soaring of prices for manufactured products, the aim had not been achieved, owing mainly to lack of large deposits of coal and iron, to the historical backwardness of industrial and commercial organization, and to lack of capital.

The National-Peasant Party, which has put through the new legislation, is obviously, as its name implies, interested in the promotion of agriculture. It has therefore swept away the export duties on agricultural produce, which had hindered the export of Romanian wheat in particular, and has passed various laws to promote a better system of agricultural credit and to organize agricultural instruction.

In addition, the problem of handling to best advantage the vast state properties and interests has received much attention. These interests include the state railways, roads, and postal communications. The reorganization of the state railways, under the advice of foreign experts, has taken the initial form of the establishment of a public body, known as the Autonomous Romanian Railways Corporation, which is to be administered according to commercial principles in the national interest (*cf.* p. 50). It may be noticed here that the writer is somewhat partisan in making no reference to the fact that the Bratianu Government had also decided to reorganize the railway administration, and had also consulted foreign experts both as to financial and technical reorganization.

Lastly the measures to increase foreign trade include the very important step of removing the disabilities on the introduction of foreign capital, and such practical reforms as the development of the Free Zones (already established in theory) at the principal Romanian ports. M. E. S.

THROUGH AMANULLAH'S AFGHANISTAN: a Book of Travel. By SORAB K. H. KATRAK. *Karachi: The Sind Observer* (*London: Luzac*) 1929. 10×7 *inches;* xxxiv+146 *pages; illustrations and map.* 10*s*

The author of this book is a merchant traveller and his knowledge of Afghanistan has been gained as such. It is not quite clear how long he spent in Afghanistan, but his observations are largely superficial.

A glance at the book shows that more than half consists of extracts from the works of other authors, which are however acknowledged in an appropriate manner. The first chapter, for instance, is headed "Geography of Afghanistan," and opens with a long extract from the 13th edition of the *Encyclopaedia Britannica*, and after four and a half lines of the author's own words comes an even longer extract from Elphinstone's 'Account of the Kingdom of Caubul.' This is followed by another long quotation from Sirdar Ikbal Ali Shah's 'Afghanistan of the Afghans,' which again is followed on the next page by extracts from the same two books and from Mrs. Lilian A. Starr's 'Tales of Tirah and Lesser Tibet.' The rest of the book is in the same style. Although this proves that the author has studied the literature on this country it does not seem an adequate reason for producing yet another book on the same subject.

The volume, which was printed in Karachi, is illustrated by a number of small photographs, some of which have suffered considerably in reproduction. The type is however clear. An incomplete bibliography, index, and an indifferent sketch-map are also included. B. K. F.

CEYLON. By ASHLEY GIBSON. Illustrated by BARBARA SHAW. (The Outward Bound Library.) *London and Toronto: J. M. Dent & Sons* 1929. 7×5 *inches;* xviii+236 *pages; and illustrations.* 5*s*

This little book is the seventh of the fascinating series which go to form the Outward Bound Library. The author has a genuine love for the Cingalese (he prefers the spelling as Sinhalese) and has a remarkable aptitude for descriptive

writing of luxurious scenery. He describes the kraaling of elephants and revels in the past history of Kings and Princesses with exceedingly long names. He gives us some real information about the gem industry and all the frauds behind it. One would have liked to see a little more space given to the Ceylon planter with his pluckers, his Kangannies, and his labour troubles. One is inclined to regret the omission, for the planter's life has much of that particular colour which Mr. Ashley Gibson seems to employ with such remarkable effect.

The library of books on Ceylon is not extensive and we welcome this volume as a valuable and agreeable acquisition. H. P. W.

THE GREAT WALL OF CHINA. By L. NEWTON HAYES. *Shanghai: Kelly and Walsh* 1929. 8×6 *inches;* xii+56 *pages; illustrations and map.* $2.50 (*Shanghai currency*)

The writer of this book has travelled along the Wall, and from general impressions one gathers that he really knows a great deal about it. As far as this book is concerned however he keeps his knowledge a carefully guarded secret and gives us partly potted second-hand history and partly moral reflections on matters relating to the Wall. He does not, as far as can be seen, contribute any new fact or enlarge our geographical knowledge. The photographs are excellent and well chosen, though the block-maker has not taken full advantage of them. There is a map, but not a very good one. Perhaps an index could hardly be expected: at any rate there is none. L. H. D. B.

HEBREWISMS OF WEST AFRICA: from Nile to Niger with the Jews. By JOSEPH J. WILLIAMS, S.J., PH.D. *New York: Lincoln MacVeagh* (*The Dial Press*) 1930. 9×6 *inches;* viii+444 *pages; illustrations and maps.* $7.50.

The author of this work was struck by resemblances between Ashanti customs imported into the West Indies in the days of the slave trade, and ancient Jewish ritual and belief. This led him to explore with surprising assiduity a very large number of modern books on the West Coast of Africa which are of very unequal value as authorities, and to cull from them many passages which tend to support the thesis indicated by the sub-title of the book "From Nile to Niger with the Jews."

Criticism is disarmed by the frank statement of the author that his book does not profess to prove that Jewish migrations, which are inferentially assumed to have taken place, did in fact take place. Mediaeval African geographers, who mostly wrote in Arabic, are ignored; as are also more ancient sources of information. There are many rash assertions, and many still rasher derivations, as for instance on p. 299, that the people name "Kanuri" may come from Hebrew "Kinor," a *lyre*, and on pp. 342 and 343 that the name of the Ashanti supreme god, "N'yame," may come from that of the Hebrew "Yahweh."

The book in fact would have been much more valuable and probably a good deal shorter had its author had more first-hand acquaintance with Africa than appears to be the case; for he would then in his voluminous reading have been able to winnow the grain from the chaff, and accept with a sufficient amount of salt the theories of Nahum Slouschz and Felix Dubois and other writers of the romantic African school, on whom he seems to rely more than is wise. Yet when all the criticisms—and they are many—to which this work lays itself open are made, and even if it is not quite as its publishers maintain, "A fascinating and important contribution to African Archaeology (*sic*)," it is a most painstaking effort to collect from sources readily accessible evidence which tends to support in part Elliot Smith's "diffusionist theories." But the influences which have moulded the Sudan from east to west have been of great variety and complexity,

they have been mainly oriental and external, coming ultimately from east and north—so that little Sudanese culture is due to the Sudanese themselves or to their neighbours farther south, the negroes. Thus Sudanese culture, which includes Ashanti culture, doubtless does in some measure owe something to Jewish or Phoenician influences which were at one time strong in the Sahara and particularly the Western Sahara; but there is no evidence of any migrations which can properly be designated "Jewish" or "Hebrew" ever having passed from the Nile to the Niger in the Sudan belt at any time.

If Father Williams were content with suggesting that Hebrew or Phoenician merchants were largely responsible for the rise of the ancient Songhai capital Kukia as a trading centre, the suggestion, though not original, would commend itself as very probable; but the idea that the Songhais, complete with their culture, migrated as a people from the Nile to the Niger is a theory opposed to all probability, and negatived by all authority and tradition that exists. H. R. P.

THE BIRDS OF TROPICAL WEST AFRICA, with special reference to those of the Gambia, Sierra Leone, the Gold Coast, and Nigeria. By DAVID ARMITAGE BANNERMAN. With a Preface by the Rt. Hon. Lord PASSFIELD. Vol. I. *Westminster: The Crown Agents for the Colonies* 1930. 11 × 7 *inches;* lxxvi + 376 *pages; illustrations and maps.* 22*s* 6*d*

The Governments of Gambia, Sierra Leone, the Gold Coast, and Nigeria have undertaken the publication of a standard work on the birds of West Africa: it is a fine example of official recognition of science that might well be copied by other Governments. They may also be congratulated on their selection of Mr. D. A. Bannerman, a Fellow of our Society, as the author, for the quality of his work on the birds of Tunisia and the Canary Islands is recognized by all ornithologists.

The main object of this book is to enable the observer in the field to identify the birds he sees. For until this can be done it is impossible for planters or district officials of the administration to collect evidence as to the economic importance of different species, and so to take suitable measures for the protection of those which are valuable for the health of the community and the success of agriculture. With this object in view most ingenious "keys," illustrated with drawings by Mr. Grönvold, have been prepared: from them even the novice should be able to run down the Order and Genus of any bird he gets a good look at. If he can obtain a specimen, then further reference to the keys in the body of the work will enable him to identify the actual species with far less difficulty than is usual with systematic text-books.

But we are concerned with the geographical aspect of this book. It is refreshing to find an author so learned in his own branch of study who is still able to keep and hold broad views. Thus he points out to start with that we cannot get a right conception of bird life in West Africa except by taking a very large area under review, and we are given a geographical survey, which, rightly ignoring political frontiers, covers the whole area between the Senegal and the Congo. The very beautiful new vegetation map, for which Mr. H. F. Milne deserves our congratulations, is just as essential to the geographer as to the ornithologist, and since Mr. Bannerman is supported by the botanical authority of Dr. Chipp we may consider this map as more authoritative than any yet published, as it is certainly the clearest and most attractive. It is well worth study by all geographers.

It is essentially the distribution of vegetation which determines the composition of the avian population over the world: and in the case of land-birds at least it also determines their migrations. In Africa the zones of vegetation run from west to east, and not from north to south, and therefore the avi-faunal regions also follow this alignment. So to the geographer the main interest of the present

volume lies in the introductory pages where the author, in collaboration with Dr. Chipp, describes and relates the vegetation zones and the faunal areas.

The maritime forests of mangrove, peculiar to the tropics, and the freshwater scrub vegetation, the "sudd," well developed in our area at Lake Chadd, are special local units of great interest to the naturalist but more or less accidental in location to geographers. This applies also to a lesser degree to the montane belt. The montane vegetation of West Africa, allied both to the Mediterranean and to the South African mountain flora, is represented at Futa Jalon in French Guinea, the Bauchi plateau, and the Cameroons (13,353 feet). It harbours a peculiar bird population allied on one side to that of Ruwenzori, Elgon, and even Shoa 1700 miles away, and on the other to the avi-fauna of Clarence Peak on Fernando Po. It appears to be a case of discontinuous distribution of families which were formerly spread broadcast over the land, now separated from one another by hundreds of miles of intervening hostile territory. We know that considerable changes in topography must have occurred through recent geological history, and we are driven more and more, despite adverse criticism, to believe in climatic changes also. In brief these birds find only in the montane belt those climatic conditions to which they were originally accustomed.

But we are still more concerned with those great zones, physical, climatic, botanical, and geographical which stretch latitudinally right across the middle of Africa. Firstly comes the Saharan belt, from the Atlantic to the Red Sea, while the Saharan Avi-faunal belt may be extended into Arabia. South of this comes the Thorn-scrub Savanna stretching from Senegal to the Eastern Sudan, which corresponds to the Sudanese Arid avi-faunal area. It is interesting to see that Dr. Chipp on botanical grounds confirms Admiral Lynes' prediction, arrived at from his study of the birds, that this belt is pushed up north of the Gambia river at its western extremity. Next comes the Savanna or Grass-woodland belt of the botanists, extending from the Atlantic to Abyssinia and Uganda: it constitutes by its variety perhaps the richest bird area of all. This type of vegetation is found again south of the equatorial forest belt, which indeed it appears almost to surround, and for avi-faunal purposes is here described as the Southern Congo Savanna. Finally we come to the tropical forest belt, which extends from the coast to the Great Lakes, represented in West Africa by the Upper and Lower Guinea Forests. This close-canopy forest supplies our first really sharp line of demarcation, forming as it does an absolute barrier, greater than the Sahara itself. Thus palaearctic migrants following the east coast are found wintering at the Cape, while on the west coast their passage seems to stop abruptly in Nigeria. Mr. Bannerman believes that such birds which eventually reach Damaraland do so by way of the Great Lakes rather than across the forest. In the closed forest bird associations are found living as in "flats," one above the other, with little mingling between the different levels of society.

The author, by his previous work in the Canaries, is exceptionally qualified to speak on the effects of isolation of species in islands, and his all-too-brief treatment of the subject must stimulate the appetite for more. He does not exaggerate when he writes that on Fernando Po "we can see evolution at work."

We have dealt but briefly with certain topics of the widest interest to geographers which are mentioned in the introductory pages. As a book on birds this volume is remarkable equally for its authority and for its simplicity of language and ease of use by the amateur. Its possession cannot but add greatly to the interest and pleasure in life of every official, trader, and planter living in any part of West Africa. Though technical terms are banished whenever possible no serious student of birds can do without it, and it is to be hoped that the publication of the four succeeding volumes will not be unduly delayed. T. G. L.

GO WEST—GO WISE! A Canadian Revelation. By MARJORIE HARRISON. *London: Edward Arnold & Co.* 1930. 8×5 *inches;* x+308 *pages; and illustrations.* 7*s* 6*d*

The title of this book sufficiently expresses its purpose. Miss Harrison in writing it has had the laudable intention of giving both sides of a difficult question. It is of course a known fact that occasionally emigrants from England have been disappointed on arrival in Canada, and in some cases have even returned to the Old Country. The remedy according to the author is to know the disadvantages before one starts. But it may be doubted whether this account of a Canadian visit, seldom far from the beaten track, really accomplishes the end she has in view. Many of the discomforts she describes are inseparable from any pioneer settlement, and the vagaries of the weather are not peculiar to Canada. There are several contradictions. She speaks of the lack of adequate medical aid, but admits that much is being done to remedy the defect; she condemns the emigration posters, but paints a picture of a golden harvest almost similar. She does well however to point out the danger of the foreign influx, chiefly from Eastern Europe, into the middle provinces, which accounts for 48 per cent. of the entire population of Manitoba, Alberta, and Saskatchewan, and of the American invasion of money and manners in most of the Dominion. With her conclusion as to the potential wealth of Canada and the need of a rapid increase in population no one will disagree.

Miss Harrison has her lighter moments, and there are amusing accounts of life among the cowboys and of the Calgary Stampede. But it is as a serious description of the conditions of life in Canada that the book must be classed, and as such it will repay close and careful study. A. W. S.

THE WILDERNESS OF DENALI. By CHARLES SHELDON. With an Introduction by C. HART MERRIAM, M.D. *New York and London: Charles Scribner's Sons* 1930. 10×7 *inches;* xxv+412 *pages; illustrations and map.* 21*s*

Charles Sheldon was one of America's most famous hunters, and an excellent field naturalist in addition. His haunts were every mountain slope to be found between Mexico and Alaska. The present volume deals with the Mount McKinley region, or, as the author properly prefers to call it, using its Indian name, Denali. The book will certainly give pleasure to students of wild life. It deals with remote regions difficult of access, where rock, snow, ice, and dwarfed vegetation form the most striking features of the scenery. The narrative is told in the form of a diary, and the shooting incidents are described in detail by one who has good powers of observation. The wild sheep come in for most attention. They were the author's speciality, and he gives us an immensity of information on matters connected with their natural history. Also much is told about shooting adventures with caribou, moose, grizzly, and lynx. There are good descriptions of mountain scenery, side lights on the less conspicuous animal inhabitants, and narratives of difficult and laborious scrambles over mountain, glacier, and moraine.

The author not only shot large game, but collected many of the smaller mammals, several of which were new to science. Some of his observations on natural history are particularly striking and valuable; for instance, his accounts of the mating contest of wild rams, his observations on the food-storing habits of jays, his detection of how the lynx overcomes its victim by gouging out its eyes. It is a narrative well told, and very well illustrated. The wonderful fauna which it discloses will charm both the hunter and the student of nature. And the reader

will surely close the book with no small feeling of satisfaction that the mountain wilderness through which he has wandered is now established by legislation as a permanent National Park. R. W. G. H.

MACHU PICCHU: a citadel of the Incas. Report of the Explorations and Excavations made in 1911, 1912, and 1915 under the auspices of Yale University and the National Geographic Society. By HIRAM BINGHAM. *New Haven: Yale University Press* (*London: Humphrey Milford*) 1930. 12×8 *inches;* viii+244 *pages; illustrations, plans, and map.* $5o

It is nearly twenty years since Professor Hiram Bingham of Yale University began the explorations in the southerly Peruvian Andes which ended in a thorough scientific examination being made of the remote city of the Incas, Machu Picchu. Expeditions were carried out in 1911, 1912, and 1915 under the auspices of Yale University and the National Geographic Society of Washington; the magnificent ruins were surveyed, many excavations carefully made, forest trees cleared from the intricate and extensive walls, and the surrounding country searched and mapped. Many hundreds of photographs were taken and drawings made of details of the ruins and of objects found. Every fragment of evidence that could shed light on the inhabitants of the place was collected, and many caves in the neighbouring mountain cleft were examined for burials. South of Panama no American race has left written records; the story of such people as the builders of Machu Picchu is therefore a matter of tradition, inference, and study.

The site lies a few days' journey from Cuzco, on a ridge between two mountain peaks towering over the canyon of the Urubamba river, whose bed is in this region raised some 6500 feet above sea-level; precipices fall away sheer from many walls, and the whole scene is one of wild grandeur. Owing to the inaccessibility of the place, Machu Picchu had never been examined until Professor Bingham and his party began work in 1911; although the fine site of Ollantaitambo, comparatively nearby, had been carefully described by Squier as far back as the middle of last century.

The splendid architecture, the beautiful stonework, the extent and superb position of the Machu Picchu citadel renders it of first-class importance among American pre-Columbian remains. The Bingham expedition found more than one hundred stairways within the city precincts, and houses able to shelter thousands of people. The site, Professor Bingham considers, was chosen for its defensible qualities, and hundreds of cultivation terraces (*andenes*) are still to be traced, proving the care with which food supplies were maintained. The walls of the buildings are in part of huge megalithic blocks, fitted together in typical Inca, and some in pre-Inca, style; many houses show "windows" unusual in ancient Peruvian construction; water conduits, mortars for grinding corn, bronze and small silver utensils, and fine pottery were found, eloquent of Inca culture. Skeletons were discovered in caves used for burials.

Certain of Professor Bingham's suggestions with regard to Machu Picchu have not found favour with archaeologists; but unstinted praise is due for the difficult and scrupulous work performed in the uncovering, description, and recording of the ruins. It will be remembered that a special number of the *National Geographic Magazine* was devoted to the Expedition's discoveries in April 1913, while 'Inca Land' (1922) included an account of the finding of the site. The present volume supplements these descriptions.

Publication of this complete record has been long delayed, but the volume is none the less welcome. The format is a work of art, paper and type are excellent, and the reproduction of a magnificent series of views is admirable. L. E. E.

GREENLAND, ITS NATURE, INHABITANTS, AND HISTORY. By TH. N. KRABBE. (In Danish and English: Translated from the Danish by ANNIE L. FAUSBØLL.) *Copenhagen: Levin and Munksgaard* (*London: Humphrey Milford*) 1930. 13×10 *inches;* xvi, 130+[340] *pages; illustrations and map.* 33*s* (*cloth* 40*s*)

Dr. Krabbe has spent twenty years in Greenland, first as a district doctor, and later as a visiting medical officer. Based on this long and intimate acquaintance he has written a general and popular account of the country (printed in Danish and English in parallel columns) of 130 pages, followed by 170 full-page photographs. The illustrations are all of first-rate quality and carefully selected; together they give an excellent idea of the harbours and trading stations and of the people themselves. The descriptive portion is not so final or authoritative as the three recently published official volumes of 'Greenland' (see *G.J.*, vol. 72, p. 484; vol. 74, pp. 492–493); it is the illustrations however which constitute the main feature of the book, and they make it a useful and extremely interesting volume.

J. M. W.

DEPOSITION OF THE SEDIMENTARY ROCKS. By J. E. MARR. *Cambridge: University Press* 1929. 8×5 *inches;* vi +246 *pages; and diagrams.* 7*s* 6*d*

The igneous rocks present so many problems that could only be solved by the microscopic study of thin sections that they for long almost monopolized that method of petrographic research; but in recent years more attention has been devoted to the detailed study of the sedimentary rocks. In this work Professor Marr summarizes knowledge of the conditions of their deposition and the interpretation of their evidence as to the past history of the Earth.

The book begins with the bases of geological chronology and anticipates that in time the geographical terms which are used for most of the geological formations will be replaced by a nomenclature based on fossils. The author next considers how the divisions are correlated and what are the restrictions on the methods used. Then follow the distinctions of the land and aqueous deposits, and of their subdivisions. The largest part of the book consists of the six chapters on types of sediments, their classification by modes of formation, and their distribution. The final chapters deal with the climatic belts and the principle of uniformity. Each chapter is a lucid and philosophic essay, and is illustrated from the author's wide field experience, especially of the older rocks of the north and west of England.

The book corrects many widespread misconceptions: thus the author points out that the chalk is not an abysmal deposit, and this conclusion is fully supported by studies of the bathymetric relations of chalk fossils such as that by Schrammen, who from the sponges estimated the depth at 300 fathoms. Professor Marr accepts the Barbados deposits as being established as deep-sea oozes by the full evidence available. He justly points out that all radiolarian and diatomaceous beds are not abysmal in origin; but the number of fossil deep-sea deposits has been greatly increased in recent years, especially in the East Indies.

The term "mud" is adopted for the deposits generally known as clay, following the course set by Sir John Murray, who clung to the view that clay is necessarily composed of silicate of alumina; that definition has now been generally abandoned, and the essential character of clay is based on the fineness of the particles and not on their chemical composition. Mud is regarded as a loose clay mixed with water.

Professor Marr supports the marine origin, at least in part, of the Old Red Sandstone, which is now generally accepted as a subaerial deposit. It is true, as he remarks, that marine fossils occur in the Old Red Sandstone in South Wales;

but they are there in one district, near the southern border of the formation, where an occasional invasion of the sea is not surprising. The distinctness of the fauna in that marine band emphasizes the non-marine origin of the formation as a whole. The remark on p. 130 that the Jurassic iron ores are not metasomatic might be read as applying to them all, whereas that origin has not been disproved for some of them.

The book is short; it is a model of clearness and compression; it is illustrated by instructive diagrams; and it forms a most valuable and interesting introduction to the study of the sedimentary rocks. J. W. G.

STUDIES IN REGIONAL CONSCIOUSNESS AND ENVIRONMENT. Essays presented to H. J. Fleure. Edited by IORWERTH C. PEATE, M.A. *Oxford: University Press* 1930. 10×7 *inches;* xii+220 *pages; illustrations, diagrams, and maps.* 21*s*

The "Festschrift," though familiar enough on the Continent, is a somewhat rare phenomenon here. This may be a mere matter of accident, though there is no doubt that to the severely practical mind such a form of publication has its disadvantages. From one point of view the dedication by a number of students and disciples of pieces of their own work to the teacher who has inspired it and them is a peculiarly graceful compliment; in this particular case the fact that Professor Fleure, after twenty-five years of work on the staff of the University College of Wales, Aberystwyth, is leaving for another University, offers an appropriate occasion. On the other hand, those interested in bibliography are apt to regard such collections as a needless complication of a problem already difficult enough. The problem arises even when the name of the teacher concerned is associated closely with one particular aspect of research: it is accentuated when, as with Professor Fleure, his interests are wide and varied and his students have diverged in a number of directions.

Those who have had little personal experience of cataloguing and indexing, or of the more laborious task of tracking references, may regard the objection as trifling, even while they admit that the inclusion of papers dealing with pure geography, historical geography, geology, sociology, anthropology and biology (with parasitology) within one cover, and under a title necessarily vague and difficult of interpretation, does tax the ingenuity of the librarian. But there is, we think, even more than this. The individual authors must feel, subconsciously at least, that their contributions are liable to be overlooked by the audience, often a small and specialized one, to which any piece of research must make its appeal and by which its value must be estimated. It is here that we come to the heart of the problem. Is the individual to give of his very best knowing that expert evaluation may be lacking and his labour thus largely lost; or is he to give preliminary results only, leaving fuller development for a more appropriate medium; or is he merely to present broad generalizations rising out of the work on which he is engaged? Of the three possibilities the first is probably the least likely and even the least desirable. In the present case, certainly, the most important purely geographical papers are those which fall into the second category.

Among them the first two papers—that called "An Outline of some Factors in the Development of Russia, with special reference to European Russia," by R. M. Fleming, and that entitled "Notes on the Limits of certain Cultures in Spain," by F. F. Laidler—stand out. Both, particularly the first, contain a number of extremely useful sketch-maps, and both, it may be hoped, are first outlines of investigations which the authors will develop more fully and publish elsewhere at a later date. Miss Laidler's paper, as its title indicates, is rather in the form of notes on the accompanying sketch-maps than of a developed theme.

Elaboration is very necessary and we note that the statistics given are not dated and do not always correspond with those found in the current issue of the 'Statesman's Year-book.' While also some very interesting figures are given in regard to the climatic factors influencing the distribution of crop-plants, the method by which these are obtained is not made clear. Miss Fleming's paper is a much more elaborate piece of work, and we may perhaps look forward to its development in the form of a book which would give us a clearer picture of Russia than has hitherto been available in English. The mere fact that she quotes from papers published in Russian shows that she has taken her subject very seriously.

Other papers including matter of purely geographical interest are those on "The Transport Ox and the Ox-wagon in Natal," by R. U. Sayce, and on "The Pyrenees. A Geographical Interpretation of their Role in Human Times," by E. Estyn Evans. The latter has a useful bibliography.

The book is well and amply illustrated. It has no index and is bound as one would expect from the price and publishers, that is, well and solidly. It is perhaps ungrateful to point out that the Continental habit of publishing such collections unbound, and ready to disintegrate, keeps the price down and enables the purchaser to bind separately the part or parts of which he is likely to make much use, and discard what is for him the irrelevant. M. I. N.

DIE ERDE UND IHR WIRTSCHAFTSLEBEN. Parts I and II. By S. PASSARGE. *Hamburg and Berlin: Hanseatische Verlagsanstalt* (1926). 10×7 *inches;* xviii+390, *and* 374 *pages; illustrations and maps.* 36*s*

DYNAMISCHE LÄNDERKUNDE. By HANS SPETHMANN. *Breslau: Ferdinand Hirt* 1928. 9×6 *inches;* 244 *pages. M.*9.50

German geographers are very gradually changing their attitude with regard to the presentation of human geography. In their views concerning the content of geography some have already gone farther than many of their contemporaries would deem justifiable. Dr. Passarge, for instance, in his 'Die Erde und ihr Wirtschaftsleben,' in which he presents an elaborate and systematic classification of all the aspects of human geography, includes a chapter on the Kulturentwicklung der Völker, in which he deals with the danger to exact science of neurasthenic "highbrows" and the phenomenon of pacifism in the human race, ascribing it to a "degenerative domestication." In spite of his even startling excursions into other realms of science however, Dr. Passarge has laid down very carefully the lines along which he allows his ideas to move. His work is still in the German tradition of thoroughness and evenness of treatment, without relief, without light and shade. Selective treatment of a subject would still be considered disorderly, inexact, unscientific, in most German academic quarters, but the conception of synthetic description is filtering into the German schools of Geography. Dr. Hans Spethmann is the boldest exponent of the view that there must be a breaking away from the traditional lines of geographical study initiated by Ritter and followed by Richthofen and Penck, and more recently by such writers as Braun and A. Philippson, with whom the morphological aspect of geography has been the most important aspect. He deprecates the notion of a "heute üblichen länderkundlichen Schema," regarded as essential and not-to-be-departed-from by many German writers to-day. He points out the deadening effect of the accepted "schema" on the development of those wider aspects which modern study has assumed. One has been too apt, he says, to regard the object of geographical study as a static phenomenon rather than as something dynamic; to forget that, as de la Blache has put it, "the scene of man's activities is itself a living thing." In order to work out and support his thesis, Dr. Spethmann analyses the method of exposition of a number of German geographers, weighs them in the

balance and finds them, from the point of view that he is discussing, wanting, and then proceeds to demonstrate his own point of view, namely, that it is the dynamic forces that alone are important in geographical relations—the forces brought to bear by technique, by finance, by industrial crises, by the presence of minerals, by personalities, by standards of living and "kultur," by political and religious ideas and (towards the end of his list) by such physical factors as climate and land forms. Some will think that, in his anxiety to discard all the methods which he considers now worn out, Dr. Spethmann is in danger of throwing away much that is still valuable. To cut away from under the feet of the geographer the physical basis upon which he is wont to build up and put together his geographical ideas is, to say the least of it, dangerous. To claim that the geographer has nothing to do with morphology is going too far. To consider, for example, the Alps of Savoy and to say "here is a mass of mountains, it exerts such and such influences in such and such a manner," and not to point out its relation to the great Alpine system and the still greater system of fold mountains of which it forms a part and of which it is a type both statically and dynamically is like trying to make a portrait of a man's nose without relation to the rest of his face.

The short synthetic studies of typical areas with which Dr. Spethmann illustrates his thesis show that, in spite of his drastic eliminations, what he is really seeking to impart is the spirit of the area or region with which he is dealing, a live and active thing which is dependent upon and which in turn influences and modifies geographical conditions. This idea is not new to the English student of geography, who has tended to follow rather the French impressionist school than the classical German methods of geographical analysis. We welcome the new attitude among the German geographers and hope that out of it may come a series of studies that will present to us a live Germany and not a series of anatomical dissections all in similar bottles and labelled after the same fashion. But we hope that the new school, if it develops, will continue to turn out also the solid and reliable material for which Germany has been noted in the past, and that they will continue to found their geography on a firm basis of geomorphology. We cannot afford to throw away our anchors. H. O.

THE VOYAGES OF CHRISTOPHER COLUMBUS. Newly translated and edited with an Introduction by CECIL JANE. *London: The Argonaut Press* 1930. 11 × 8 *inches; 347 pages; and maps. Two guineas*

Recent works on Columbus have in general been of such a conjectural and impressionistic character that one gladly welcomes a study based first and foremost upon documentary sources. In this volume Mr. Jane has assembled new translations of the 'Journals' of Columbus's first and third voyages, preserved in part by Las Casas, his letter on the first voyage usually known as the 'Santangel' letter, his letter describing the fourth voyage addressed to the Spanish sovereigns, and the account of the second voyage written by Andres Bernaldez, not previously translated. There is thus adequate material for an appreciation of the achievements of Columbus, with the exception, perhaps, of the fourth voyage, of which a more detailed account is to be found in the 'Historie' of his son Ferdinand. In a lengthy introduction, Mr. Jane describes the circumstances in which the various documents have been preserved, and their critical value. He points out that Las Casas preserved, and in places summarized, the 'Journals' not for material for a biography of Columbus, but for his 'Historia,' which was written with a very definite aim: consequently Mr. Jane concludes, regarding the first, that it is "by no means an undeniably safe guide to the opinions of the admiral, . . . or an essentially accurate picture either of his conduct or of that of the natives."

Similarly he holds that the "Santangel" letter was probably an official communiqué published by the sovereigns. The first contention is surely lessened by the fact that Ferdinand Columbus also reproduced the 'Journal' at length, and with no considerable variations.

Finality will probably never be reached regarding Columbus's character, motives, and relations with his contemporaries. Mr. Jane's introduction however does present a consistent and plausible figure, and his arguments will receive attention because they are set in relation to contemporary Spanish history, and are not derived from exclusive concentration upon Columbus's career alone. His sketch of the economic aspect of the enterprise and of the early Spanish relations with the New World is particularly interesting. Columbus, in Mr. Jane's eyes, was, predominantly, a typical mystic of his time, and, so far as he was practical, a business man rather than a navigator. It is not easy to accept this last point entirely, for it raises a difficulty: Who was the responsible navigator on the first voyage, and how was the route selected? The name of Pinzon suggests itself here, and Mr. Jane apparently, though not explicitly, would favour this view. There is, of course, no direct evidence, and it remains that, as Mr. Nunn has pointed out, "Over four hundred years of experience in sailing the Atlantic has not suggested any material change in the route chosen by Columbus on his first voyage."

Arguing from the phrase in the Capitulations that Columbus was to be secured in the rule of such "islands and mainland as he might discover or gain," and from the courses followed, he concludes that Columbus's "ultimate object cannot have been either Antilla or any other island or Catayo"; in his opinion, the Admiral was seeking a southern "terra firma," through which, in accordance with a cosmographical conception of the age, the rivers of Paradise flowed. He admits that the shores of Eastern Asia were an incidental object, emphasized to win the support of the Spanish sovereigns, from whom he had to conceal his true goal. The evidence here however is largely indirect, and it must be remarked that his account of his fourth voyage is full of insistences upon his nearness to the "Ganges" and the Aurea Chersonese. Nor do his routes afford conclusive evidence. His third voyage brought him to the region of the Orinoco delta, where he apparently failed to recognize his proximity to a new continent, and on the following voyage he directed his course farther west, and somewhat more northerly.

Two small points may be noted in conclusion: the editor accepts in the main the "Columbian tradition" for the early life. He rejects however the account of Columbus's arrival in Portugal—he was said to have swum ashore after his ship had been burnt by corsairs off Cape St. Vincent. His son's account is admittedly confused, but weight must be given to the circumstance that the destruction of Genoese galleys in this neighbourhood in 1476 is historical, and that among the merchants involved were the Spinolas with whom Columbus seems to have been particularly intimate.

His reason for accepting the authenticity of the voyage to Guinea, on the other hand, seems a little disingenuous. He believes in it because Columbus erroneously states that "La Mina da Ouro" lay under the Equator: had he merely derived his information from one of the many skilled Portuguese pilots it would more likely have been correct! Yet actually in holding this mistaken belief, Columbus is in the company of many contemporary cosmographers.

Mention must be made of the useful maps which illustrate the text, and of the very creditable manner in which the publishers have done their work.

CRUCIAL MAPS IN THE EARLY CARTOGRAPHY and Place-Nomenclature of the Atlantic Coast of Canada. By W. F. GANONG. I. *Transactions of the Royal Society of Canada*, 3rd Series, XXIII, Sect. II, pages 135–175. 1929.

Professor Ganong has been a student of this subject for over forty years, and anything he contributes to it is likely to be of the greatest value. This paper deals with the La Cosa map on which he has much to say that is new and authoritative. It is the first of a series which he intends to devote to these early maps.

The author begins by a rapid survey of the literature of the whole subject which will be of value to students of this period. He appears to have mentioned every contribution of note. As to the La Cosa map, he is of opinion that the maker deliberately placed the coast of the northern part of North America in the same latitude as Bristol, from which it was known Cabot had set sail. The longitude would also be roughly correct if one bears in mind that Cabot had sailed 700 leagues and had then coasted back for 300, leaving the distance from Bristol to the new lands to be 400 leagues. The distance from Ireland is really about 1900 miles.

Professor Ganong agrees neither with Dr. Williamson nor with Mr. Prowse as to the coast depicted on this map. He rightly placed Cavo Descubierto on Cape Breton island but prefers Cape St. Lawrence and St. Paul's island to Cape Breton and Scatari island for the island of St. John. Instead however of identifying Cavo de S. Jorge with Cape Ray he prefers the modern Cape St. George at the northern extremity of St. George's Bay. It does not seem to have occurred to him that this name may possibly have been transferred from Cape Ray. Isla de la Trenidat naturally becomes our St. Pierrs, Miquelon, and Langlade, then three separate islands. To discover in Miquelon the S. Nicolas of La Cosa seems to be going a little too far. One would expect a French derivation such as "Little Michael."

Cavo de S. Johan he identifies with St. John's Head in Fortune Bay, which seems unlikely, while he makes La Cosa's Cavo de Ynglaterra Chapeau Rouge, a prominent point on the Burin peninsula. S. Grigor then becomes Placentia Bay and Y. Verde part of the Avalon peninsula. There is of course a good deal to be said for such a theory and no reason why it should not be correct, more especially since in Professor Ganong's opinion this open sound between Cavo de Ynglaterra and Y. Verde persists on many later maps. The reviewer however does not agree that the sound on the Mercator and Gastaldi maps comes from La Cosa. They seem more like faulty drawings of a type similar to the Harleian, especially the Gastaldi. To deduce from the Cantino map that at Chapeau Rouge the Corte-Reals came upon Cabot's mark of possession seems pure speculation, for even if he erected one in 1497, it would probably have disappeared by 1501.

A much more interesting discovery, apart from the additional island added to Kretschmer's reproduction of the La Cosa map, is contained in the statement that the *Mar descubierta por Inglese(s)* and the *Terra que foy descubierta por Bertomes* means the same thing, since the word "Breton" in those days signified the English. This is a very important find and one which does Professor Ganong the greatest credit. There has never been any explanation of the application of the term "Cape Breton," but to see in this a survival of Cabot's landfall is most satisfactory. The Oliveriana on which Mr. Prowse places so much reliance Professor Ganong dismisses rather summarily as a poor attempt to bring together some of the early data obtained by the Cabots and the Corte-Reals. In any event it is in no way helpful to an elucidation of the early discoveries of these parts.

One looks forward with great pleasure to the publication of the remaining papers by Professor Ganong on the early cartography of the gulf of St. Lawrence to the time of Champlain. H. P. B.

THE MONTHLY RECORD

GILCHRIST STUDENTSHIP

The Gilchrist Trustees again offer, for 1931–1932, a Geography Studentship of £80, tenable at any recognized School of Geography, with a view to the furtherance of improved teaching of Geography in schools. Applicants, who should be teachers with at least two years' experience, should send in their names to Professor Lyde, Yew Garth, Sandhurst, Berks, before 2 February 1931; they must give references and a full account of their previous work, and their applications should be accompanied by three testimonials. Further particulars may be obtained from H. A. Matthews, Esq., B.A., PH.D., 7 Priory Avenue, High Wycombe, Bucks.

GLACIATION IN WESTERN IRELAND

This subject is discussed by Dr. J. Kaye Charlesworth in a paper entitled "The Glacial Retreat in Iar Connact," published in the *Proceedings of the Royal Irish Academy* (vol. xxxix, Sect. 8, No. 2, 1929).

The country dealt with is that part of Iar Connact which lies between Clew Bay on the north and Galway Bay on the south, and stretches westward to the Atlantic from the shores of Loughs Corrib and Mask. It comprises South Mayo and parts of Galway known as Connemara and Joyce's country, covering an area of about 1000 square miles.

The region is mountainous, the mountains arranging themselves more or less definitely into four groups, the best known of which forms the Twelve Pins or Bens of Connemara. The other groups are the Maumturk, the Partry, and the Mweelrea Mountains, the latter attaining the highest elevation of 2688 feet, though all groups have points over 2000 feet. These mountains, which are mainly composed of white quartzite, served as the radiating point of an extensive glaciation of Western Ireland at the time of maximum glaciation, and with their intervening valleys controlled the movements of the glaciers during the retreating phase. The ice-masses which through the Glacial Period streamed outward from this region have left in the mountains and valleys of their birth and over the immediately surrounding plains an ice-dressed surface unsurpassed in the British Isles. A map embodied in the text of the paper indicates a sufficient number of the rock-striae which have been recorded to bring out very clearly the lines of the ice-flow. Thus ice-scorings reveal the existence of a system of powerful glaciers proceeding down the valleys of the several mountain groups, and also a radial and outward flow over the surrounding plains. At the maximum phase the four ice-centres were all confluent, forming one single ice-dome over all but the highest summits. The erratics confirm the story of the ice-radiation as told by the striae. During the recession of this ice across the western part of the Central Plain of Ireland a great number of moraines were laid down which have been followed and mapped. A zone about 10 miles wide divides these moraines from another set showing the extent of a later and more local glaciation centred upon each of the four groups of mountains. This probably denotes a readvance of the ice.

The influence of relief on the movement of the ice is inferred to have been most powerful during the waning phase.

ROCK-WEATHERING IN CORSICA

Alveolar or cellular structures in the faces of rocks form a type of erosion which has been recorded in both arid and humid climates, but according to a paper by Jacques Bourcart entitled "Le Problème des 'Taffoni' de Corse et l'Erosion Alvéolaire" (*Revue de Géographie Physique et de Géologie Dynamique*, vol. iii,

1930, fasc. 1) there is no country in the world where they constitute such a dominant feature in the landscape as in Corsica. The *taffoni* are roughly hemispherical cavities, of diameter varying from a few inches to a yard or more, formed in the vertical faces of granite rocks, but never on horizontal surfaces. This type of sculpture is spread over a wide area in the granite zone of Corsica, particularly in the Balagne desert, but never appears above about 3000 feet, the mountain climate being unfavourable to the process. Whilst most striking in granites, other kinds of rocks also exhibit cellular weathering, and in limestone surfaces tubes rather than niches are found. For the formation of such honeycombed rock faces two factors appear to be necessary—permeability, and abundance of salts, especially chlorides, in the penetrating waters.

The author rules out sea-spray as the cause of the *taffoni*, since they are found far inland in the shelter of deep gorges, and indicates also that they cannot be entirely due to the impact of wind-driven rain. He inclines to the view that the phenomena represent a complex chemical and physical process connected with the alternation of strong heating of the rock faces by sunshine and the infiltration of dew-water, the salts being derived from the rock itself, though in this connection no reference is made to absence of the structures from northerly exposures. The object of the paper however is not so much to account for these curious forms of disintegration as to draw attention to their importance in the Corsican landscape where they might well make a subject for research.

NORTH-WESTERN MANCHURIA AND THE REINDEER TUNGUS

In the *Journal* for June 1930 we published with Miss E. J. Lindgren's paper on "North-Western Manchuria and the Reindeer Tungus" an ethnographic sketch-map of the area dealt with in the paper. The author has since pointed out that the title of this map does not make it clear that it is not the result of her work nor does it necessarily embody her views. The map is in fact based on the Russian 100-verst Ethnographic Map of Siberia (Etnograficheskaya Karta Sibiri) published by the Commission for the Study of the Racial Composition of the Population of the U.S.S.R. and the Adjacent Countries (1927), while the sketch-map showing Miss Lindgren's route is based on the War Office 1/4million map (1921), and the Russian 40-verst map (1929). Albazi Ho in map and text should read Albazikha river.

The President has received from Professor S. M. Shirokogoroff a letter containing much useful information as to published and unpublished material dealing with that part of North Western Manchuria described by Miss Lindgren and the little-known Reindeer Tungus. We publish here certain extracts from this letter:

"The maps [of North-Western Manchuria], at least in draft, do exist. The regions of North-Western Manchuria which have been treated by Miss Lindgren had been visited by several expeditions, both scientific and military ones, and rough mapping of the country has already been done. Particularly the expedition led by me in 1915 was successful enough to have been able to cross Manchuria and thus to bind by route, with a slight discrepancy of 28 kilometres only, two astronomically defined points located at a distance of nearly 700 kilometres. A copy of the draft of my itinerary was stolen from me in 1920, together with other cartographic material, so I shall not be surprised at seeing it one day published by some undertaking person not aware of the author's right. Geographical descriptions of this part of Manchuria have been done not only in the paper quoted by Miss Lindgren, but also in my recent book ('Social Organization of the Northern Tungus with introductory chapters concerning Geographical Distribution and History of these Groups,' Shanghai, 1929. The Commercial Press, Ltd.) and in some other earlier publications of mine. The description of

my itinerary has been given in such a detailed manner that the route may be easily traced and thus the map may be corrected, at least to some extent.

"As stated, North-Western Manchuria has been visited and explored by several expeditions. The reports and accounts have been partly published and partly handed over to different institutions, thus still being accessible for scientific purposes. Together with the reports there have also been supplied materials for the correction of the map. Amongst the explorers of the Bistraya river, discussed by Miss Lindgren, there was a well-known geologist, P. Polevoi, who prior to 1915 reached the region and explored it along the lower course of the river. My own exploration has been carried out during my work in Manchuria as head of the Manchurian Expedition of the Russian Imperial Academy of Sciences, in 1915–1917, the latter being the third expedition of a series of my expeditions in Asia. Several persons have taken their part in the work of this expedition. Some geographical data have been published by Madame Shirokogoroff, who had accompanied me in this expedition (in Russian, Vladivostok, 1919). The other materials resulting from the work of the expedition and consisting of the anthropological, archaeological, ethnographical, and linguistical data being numerous require a long time for being published. However, there have already been published two volumes, and several papers (the latter being chiefly linguistical and ethnographical) concerning different groups of Manchuria and particularly Reindeer Tungus and the group that had not been visited by me according to Miss Lindgren in her lecture (an extensive dictionary of the dialect spoken by this group will be published in due time). The classification of the groups mentioned by the lecturer, also their history, and ethnographical maps have already been published. Bibliographical data as to my own publications may be found in my last extensive publication on the Tungus.

"Although this scientific undertaking of the Russian Academy of Sciences as the first important and systematic ethnological survey of Manchuria ought to be known to the scientific world it is not evidently so, for which there indeed are some reasons. The expedition was carried out during the years of the Great War, when the attention of every one was absorbed by the news from the fronts; secondly, there existed a complete disconnection between the Academy of Sciences and the outer world, owing to the political upheaval in Russia; and thirdly, I, since 1917, have been disconnected with the Academy, but am still continuing a systematic exploration (chiefly physico-anthropological) of China."

DRIFT-BOTTLE EXPERIMENTS, GULF OF MANNAR

Experiments with sealed bottles for the determination of currents in the Gulf of Mannar were initiated by Mr. J. Hornell in 1907 when adviser to the Company of Pearl Fishers, and have been more systematically pursued since 1913 (with a break in 1917–19 due to the war) under the direction of Dr. J. Pearson, Marine Biologist to the Ceylon Government. A preliminary account of the results has been given this year by Mr. A. H. Malpas in vol. 4 of the *Bulletins of the Ceylon Fisheries* which form a section of the *Ceylon Journal of Science*. The number of bottles liberated from vessels of the Ceylon Fisheries, and from those of the British India Steam Company on the Colombo–Tuticorin run, has been very great, the sixteen stations regularly adopted for the purpose covering the greater part of the gulf. The detailed statistics printed in the memoir are preceded by monthly analyses and summaries of conclusions in which use is also made of the general interpretation of the régime of the currents in this part of the Indian Ocean by the Hydrographer of the Navy. The mean drifts of such bottles as have been recovered is also shown in charts for each month from March to October, *i.e.* for the transitional period between the monsoons in March and April and for the period of the south-west monsoon. For that of the north-east

monsoon little new information has been secured, as few bottles have been recovered, most having no doubt been carried into Oceanic waters. During the south-west monsoon, as might be expected, the movement in the gulf is shown to be generally north and north-east, conforming to that of the coasts of Ceylon and Southern India respectively. According to the Admiralty interpretation, there is a general south-easterly movement of water in the Arabian Sea, which on striking the coast of India is deflected across the mouth of the Gulf of Mannar, into which some penetrates in August. On the other hand, in May and June there is some outward movement from the west side of the gulf. During the south-east monsoon the Admiralty interpretation shows a penetration of Oceanic water during November and February, but in the intervening months the strong winds cause south-westerly currents from the gulf. The bottle experiments do not reveal the northward movement in November and February, but this may be due to the bottles being eventually carried out again by a movement of rotation counter-clockwise.

AERIAL EXPLORATION IN NORTHERN CANADA

The use of aeroplanes for prospecting work over wide areas has lately been tested by elaborate operations set on foot by companies interested in mining development in Canada. The building of the Hudson Bay railway had given access to a region hitherto undeveloped, and known only from long-drawn traverses of explorers who have mostly followed the waterways, so that these have been almost the only feature shown in the maps. It had been found that work from the air could not only give a better idea of the features of the country, but could enable geologists broadly to classify areas as promising or unpromising for the occurrence of minerals. Such work however requires extensive organization in advance, and the recent operations involved the purchase of ships as well as aeroplanes, and the transport to Hudson Bay of extensive material for the equipment of bases from which the flights could be made as soon as the season was far enough advanced for the purpose. The extensive personnel included specialists in various fields. In a preliminary report issued this year by the Department of the Interior, Mr. G. H. Blanchet describes the methods adopted and results obtained by the expeditions of 1928 and 1929, which have gained experience likely to be of great use for future work of the kind. One of the ships employed ascended Chesterfield Inlet to Baker Lake, being the largest vessel that had so far navigated these waters. Besides prospecting along the shores of the bay, the various parties covered immense stretches of country in Northern Keewatin from Hudson Bay to the Thelon river, and from about 61° N. to the Arctic Ocean, extending their researches also to the Mackenzie basin and Northern Saskatchewan.

The examination of the west coast of the bay failed to reveal ore deposits likely to be of importance in the near future, but work further west in the Mackenzie District was more encouraging. Apart from the economic question the explorations have thrown useful light on the general configuration of the country, and yielded information on the climate, natives, and wild life, which is summarized in the report. Whilst the confusion of waters in the drift-covered tract west of the bay is bewildering to those travelling on the surface, a clearly marked trend of topography could be noted from the air, the effect of past glacial movement, giving to the surface the appearance of a ploughed field, in which the furrows are occupied by lakes, which sometimes stretch through gaps in the ridges between and produce extremely complicated bodies of water. The hills are here chiefly moraines and eskers, and only occasionally do rocky areas break through the drift cover. North of Chesterfield inlet there is higher and more broken country, especially towards the east. On the Arctic slope there is still more rugged

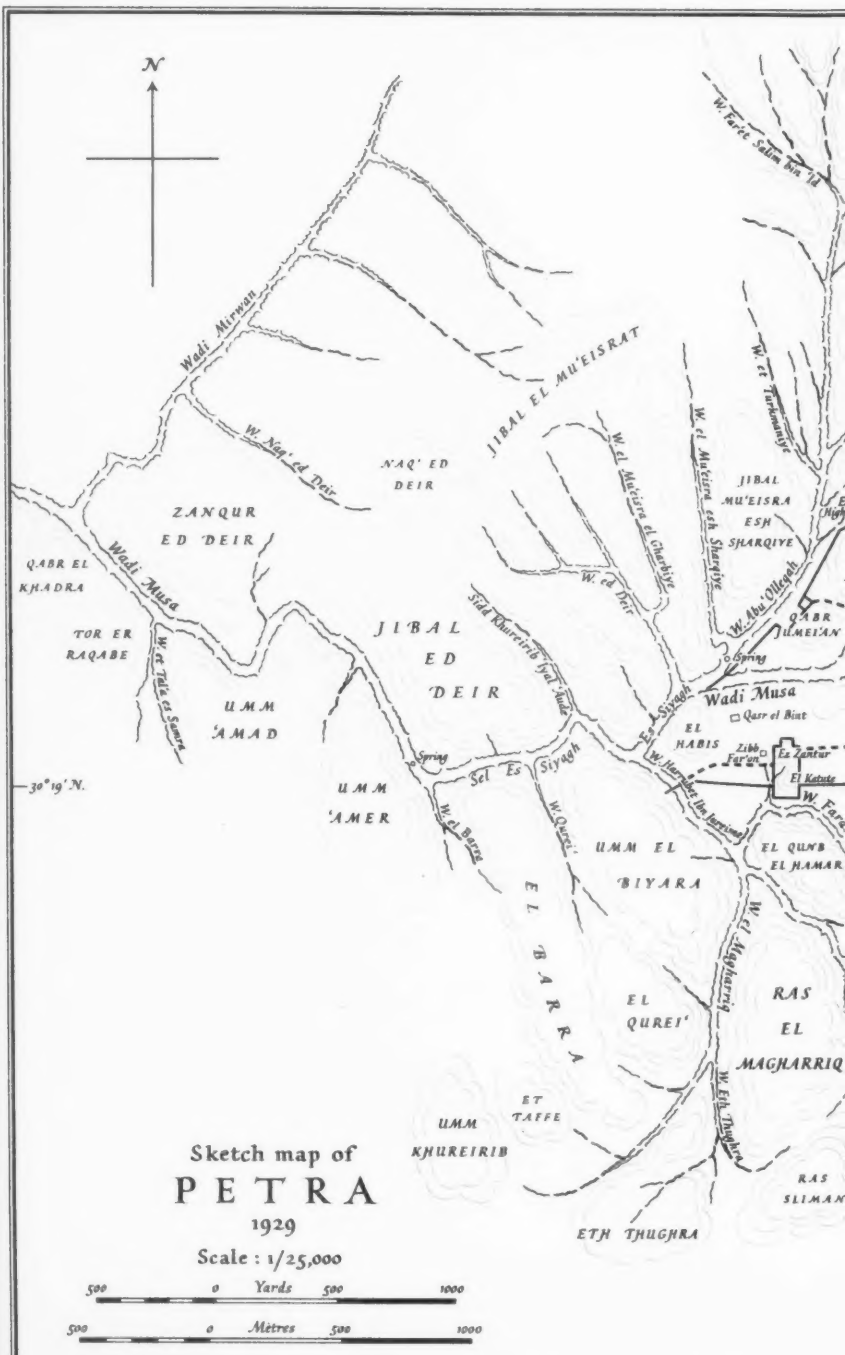
country, rising on the east coast of Bathurst Inlet to mountains of 1500 feet. The rivers in this northern tract are unlike those of the Hudson Bay plain, having well-defined beds in their lower courses. The air work on the Hudson Bay coast gave a new idea of its configuration, showing that instead of being a regular coast-line it is an area of island and reef-filled waters varying with each change of tide. Mr. Blanchet regards the climate as better than it has been painted. Apart from the regularly recurrent storms which raise the fine snow into a driving scud, the winter is pleasant for work or travel. Such storms are so consistently from the north-west that the drifts may be used as guides for travel in thick weather. Observations of the herds of caribou and their migrations showed the incorrectness of the idea that they are vanishing, though they seem to have learnt to avoid the points of danger from their human enemies. Next to caribou the white fox is the most important animal to the Eskimo, and on it the fur trade almost solely depends. Fish abound everywhere, and the sea-trout fishery along the west coast of the bay offers promise of profitable development.

THE SUN AND THE WEATHER

The *Smithsonian Miscellaneous Collections* (vol. 82, No. 7, 1930) embody the fifth of a series of papers by Dr. Helm Clayton, who is known for his researches into the effect on the weather of changes in solar activity as indicated by measurements of the sun's radiation after the methods of Dr. G. C. Abbot and his associates. The paper contains evidence pointing to the conclusion that solar activity varies in complicated pulses which are attended by variations of pressure in the earth's atmosphere. Where solar activity, as indicated by spots and radiation values, increases, the earth's latitudinal pressure belts are intensified, pressure falling in the equatorial belt, rising in middle latitudes and falling in the polar regions. In other words the atmospheric circulation is speeded up—a result quite in accordance with theory. When solar activity decreases the reverse effect takes place. The zonal regularity of these changes is disturbed by the distribution of land and water and by seasonal changes to which this distribution gives effect. The latitude pressure effect is clearest at the equinoxes, that is during the months of March and September, and most interfered with by the distribution of land and sea at the solstices, in June and December, because of the heating and cooling respectively of the continents. The greatest increase of pressure with increased solar activity is over the continents in winter and over the oceans in summer. The solar pulses reflected in the terrestrial pressure changes are of longer or shorter duration with periods ranging from a few days to a few years.

Considering the possibility of using a knowledge of solar cycles in weather-forecasting the writer says: "A study of the possibility of analysing the data at each particular part of the earth with the view to discovering fixed periodic cycles indicates that if such cycles exist the amplitudes are subject to wide variations and even to inversion of phase from time to time. However, when the complex cycles are analysed individually, and averages taken for a small number of successive cycles, it is possible to project them into the future and plot them in a curve which at times has a striking resemblance to observed data. As knowledge of methods and laws of change progress this kind of forecasting will doubtless be done with increasing accuracy." This passage at least shows a realization of the great complexity of the question, which it is fair to note because in the author's earlier work, including his book 'World Weather' (*Journal*, 64, 1924, p. 418), there is a tendency, which has been criticized, to regard the variability of the weather as a mere function of solar activity. If the sun's radiation does vary, as seems to be established, it must add another variable to the factors which control the weather; but even if it were constant there are too many terrestrial causes of variability to allow us to experience the same weather at the same date every year.

30°19'



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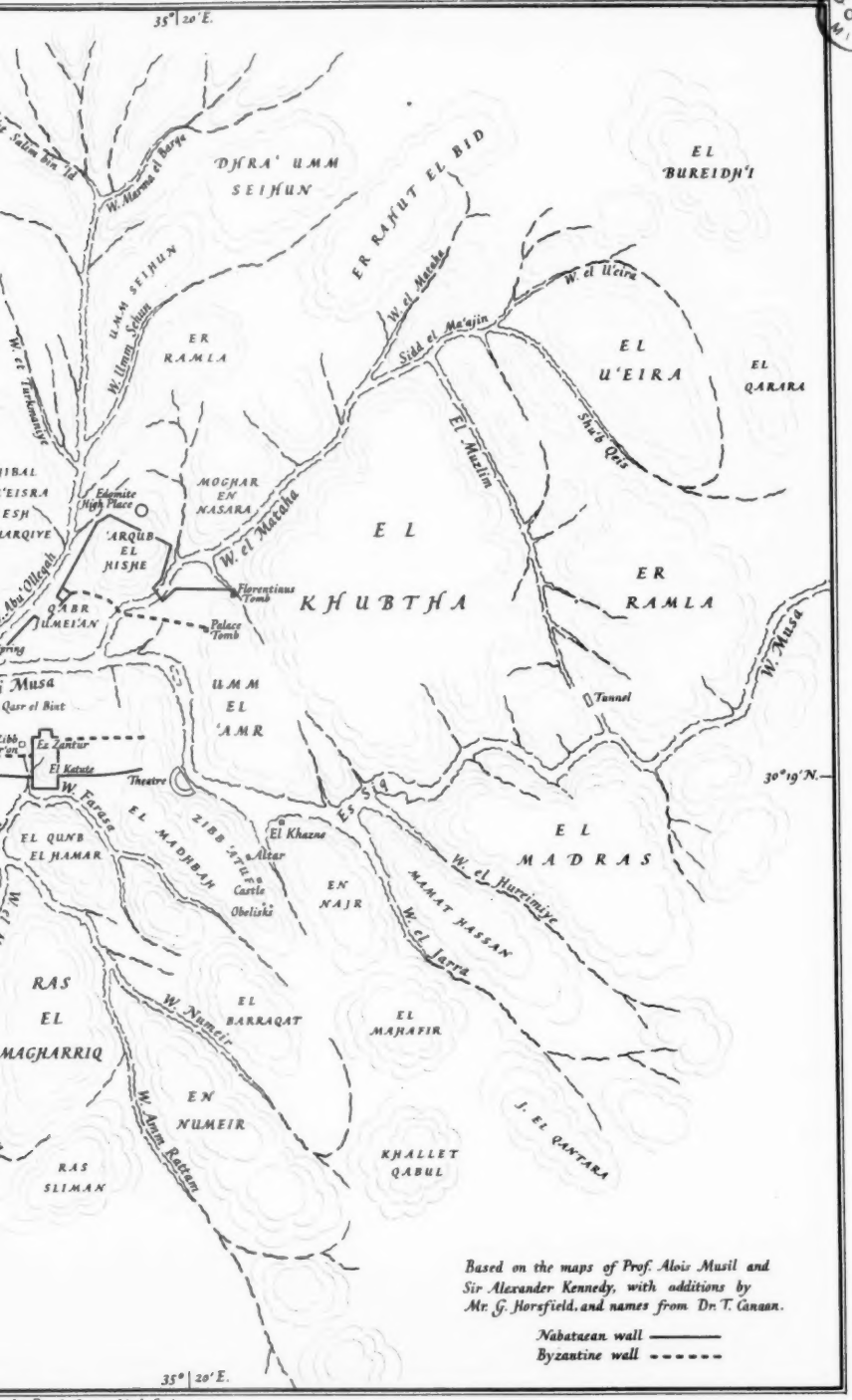

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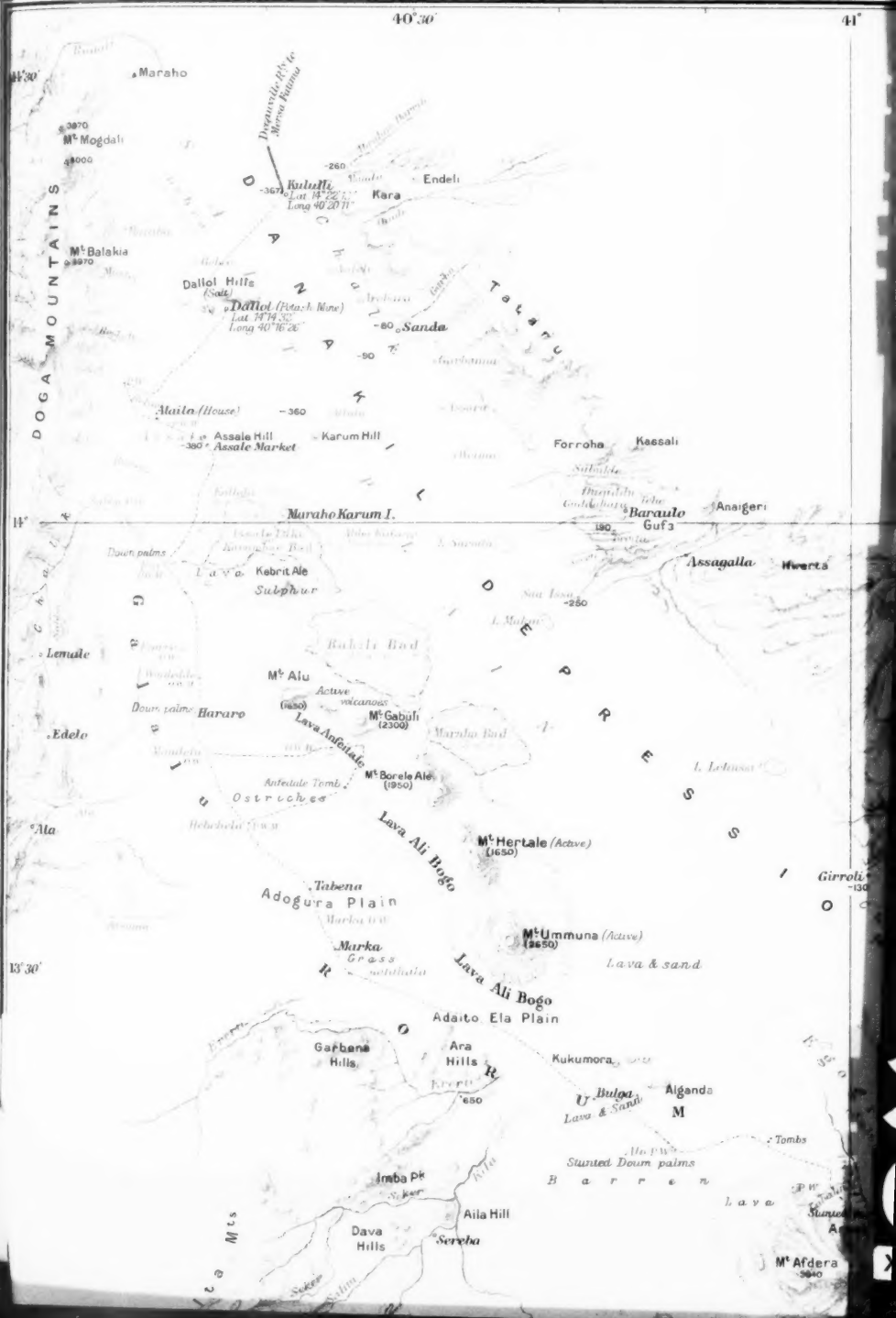
40°30'
41°
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14°
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Maraho
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3970
4000
Degaturville River
Mersa Paloma
Kululli
Lat 14°22'
Long 40°20'11"
Endeli
Kara
-260
-360
Mt. Balakia
3970
DOGA MOUNTAINS
Dallol Hills
(Salt)
Dallol (Potash Mine)
Lat 14°14'30"
Long 40°16'20"
Sanda
-80
-90
Alaito (House)
-360
Assale Hill
-380
Assale Market
Karum Hill
Forroha
Kassali
Maraho Karum I.
Baraulo
Gufa
Anaigeri
-150
Lava
Kebrit Ale
Sulphur
Assagalla
Hverta
-250
Lemule
Mt. Alu
Active volcanoes
(1650)
Mt. Gabuli
(2300)
Edelo
Harare
Lava Ad Gitale
Mt. Borele Ale
(1950)
Ostriches
Ata
Lava Ali Bogo
Mt. Hertale (Active)
(1650)
Girroli
-130
Tabena
Adogura Plain
Marka
Gross
Mt. Ummuna (Active)
(2650)
Lava & sand
Lava Ali Bogo
Adaito Ela Plain
Garbena
Hills
Ara
Hills
Kukumora
Bulga
Lava & Sand
Alganda
-650
Tombs
Stunted Doum palms
Barren
Lava
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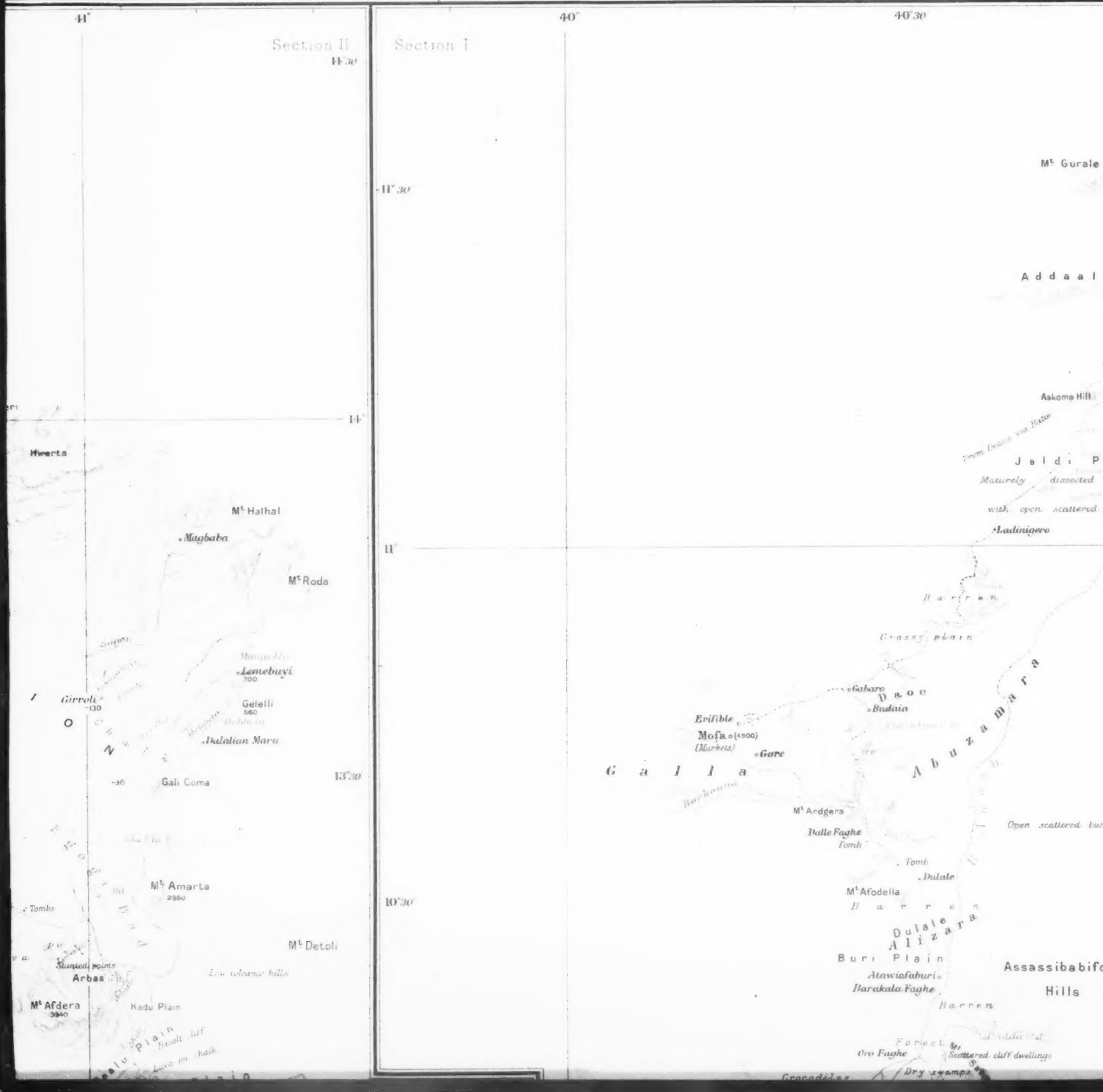
Aila Hill
Dava
Hills
Sereba
Mt. Afdera
3940
Danakil
Depression
Red Sea Mts


41°
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Magbaba
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Lemebuyi
700
Girreli
130
Gelelli
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Dalalian Maru
Gali Coma
13°30
Mt Amarta
2350
Tombs
Mt Detoli
Stunted palms
Arbas
Mt Afdera
3940
Kadu Plain
Basalt cliff
40°
Section I
40°30
11°30
Mt Gurale
Addaal
Askoma Hill
Jaldi P
Maturely dissected
with open scattered
Ladinigero
11°
Barren
Grassy plain
Gabaro
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(Markets)
Gere
Galla
Abuzamara
Mt Ardgera
Dalle Faghe
Tomb
Open scattered bus
Tomb
Dulale
Mt Afodella
Barren
Dulale
Alizara
Buri Plain
Atawiafaburi
Harakala Faghe
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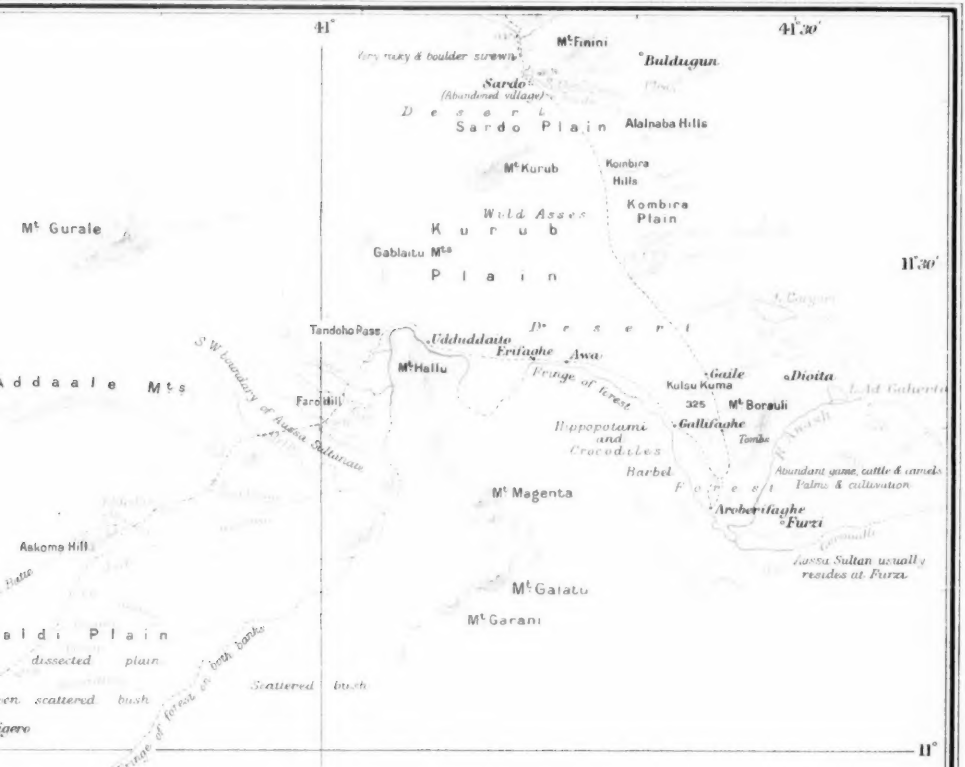
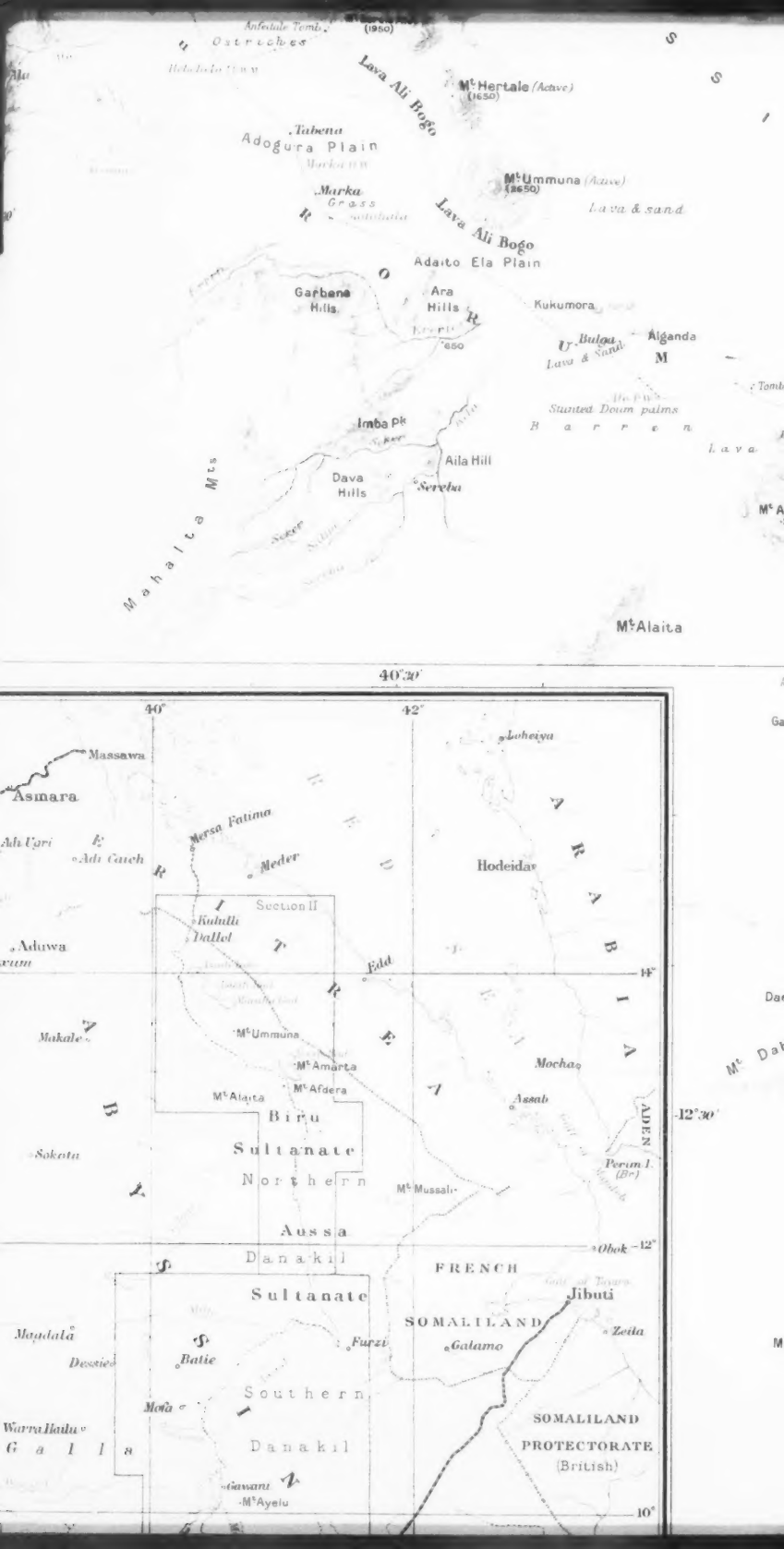
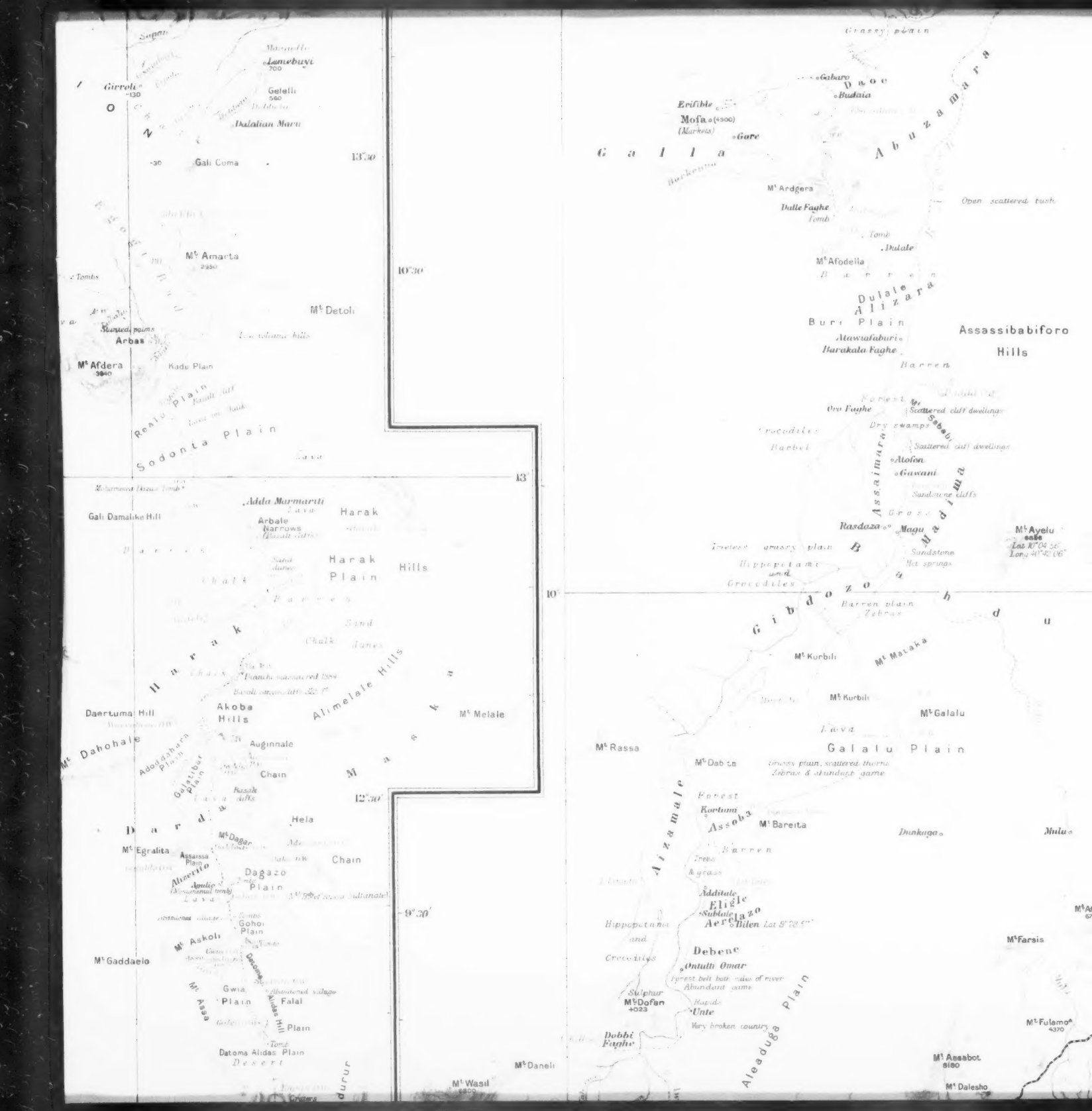
Hills
Barren
Forest
Oro Faghe
Scattered cliff dwellings
Dry swamps
10°30
Crocodiles


41°
41°30'
Mt Finini
very rocky & boulder strewn
Bulduguu
Sardo
(Abandoned village)
D e s e r t
Sardo Plain
Alalnaba Hills
Mt Kurub
Kombira Hills
Kombira Plain
Wild Asses
K u r u b
P l a i n
Gablaitu Mts
Mt Gurale
11°30'
Tandoho Pass
Uddudaito
Eritaghe
Awa
D e s e r t
Mt Hallu
Fringe of forest
Gaile
Dioita
Kulsu Kuma
325
Mt Borauli
Gallitaghe
Tombs
Hippopotami and Crocodiles
Barbel
F o r e s t
Abundant game, cattle & camels
Palms & cultivation
Mt Magenta
Archeritaghe
Furzi
Assa Sultan usually resides at Furzi
Askoma Hill
Mt Galatu
Mt Garani
dissected plain
scattered bush
Fringe of forest on both banks
11°
ABYSSINIA
Route Traverse
from
South to North
through
DANAKIL
by
L. M. Nesbitt
1928
10°30'
Scale 1:750,000
5 0 5 10 15 20
Statute Miles


Infedale Tomb
(1950)
Ostriches
Lava Ali Bogo
Mt Hertale (Active)
(1650)
Tabena
Adogura Plain
Marka
Grass
Mt Ummuna (Active)
(2650)
Lava & sand
Lava Ali Bogo
Adaito Ela Plain
Garbena Hills
Ara Hills
Kukumora
Bulga
Lava & Sand
Alganda
Stunted Doum palms
Barren
Lava
Imba Pk
Aila Hill
Dava Hills
Serelu
Mahalea Mts
Mt Alaita
40°30'
40°
42°
Massawa
Asmara
Adi Ugri
Adi Caieh
Mersa Fatima
Meder
Luheiya
Hodeida
Section II
Kubilli
Dallol
Aduwa
Edd
14°
Makale
Mt Ummuna
Mt Amarta
Mt Afdera
Mt Alaita
Birru
Sultanate
Northern
Assa
Mocha
Assab
ADEN
12°30'
Perim I. (Br)
Sokota
Mt Mussali
Obok
12°
Danakil
Sultanate
FRENCH
SOMALILAND
Jibuti
Zeila
Galamo
Furzi
Magdala
Dessie
Batie
Southern
Danakil
Mola
Warra Haiu
Gallas
Giawani
Mt Ayelu
SOMALILAND
PROTECTORATE
(British)
10°

Sugan
Mangolla
Lemebuyi
700
Girroli
-130
Gelelli
560
Ibalalian Maru
-30
Gali Coma
13°30'
Mt. Amarta
2950
Tombs
10°30'
Mt. Detoli
Lava
Stunted palms
Arbaa
Low volcanic hills
Mt. Afdera
3940
Kadu Plain
Basalt cliff
Lava on chalk
Sodonta Plain
Lava
13°
Mohammed Dazaa's Tomb
Adda Marmariti
Gali Damalike Hill
Arbale Narrows
Basalt cliffs
Harak Plain
Harak Hills
Barren
Sand dunes
Chalk
Sand
Chalk dunes
Harak
Alimelale Hills
Massa
Bianchi massacred 1884
Basalt canyon cliffs 325 ft.
Daertuma Hill
Akoba Hills
Mt. Melale
Mt. Dahohale
Auginnale
Mt. Rassa
Adoddahara Plain
Galalibar Plain
Chain
Massa
12°30'
Basalt cliffs
Hela
Mt. Egralita
Mt. Dagar
Assaissa Plain
Chain
Aizerrito
Dagazo Plain
Aizamale
Aquilie
Monumental tomb
Lava
Tombs
Abandoned village
Gohoi Plain
9°30'
Hippopotamus and Crocodiles
Mt. Askoli
Mt. Gaddaelo
Datoma
Gwia Plain
Abandoned village
Falal Plain
Mt. Assa
Alidas Hill
Sulphur
Mt. Dofan
+023
Dobbi Faghe
Tomb
Datoma Alidas Plain
Desert
Mt. Daneli
Mt. Wasu


Sugan
Lemebuyi
700
Girroli
-130
Gelelli
560
Dalalian Maru
-30
Gali Coma
13°30
Mt Amarta
2950
10°30
Tombs
Mt Detoli
Arbas
Mt Afdera
3040
Kadu Plain
Sodonta Plain
Lava
13°
Adda Marmariti
Gali Damalike Hill
Arbale
Narrows
Harak
Harak
Plain
Hills
Chalk
Sand
Chalk Dunes
Harak
Akoba
Hills
Alimelale Hills
Daertuma Hill
Mt Melale
Mt Dahohale
Auginnale
Chain
Adoddabura Plain
Galatibar Plain
12°30'
Hela
Mt Dagar
Mt Egralita
Assarssa Plain
Chain
Dagazo
Plain
Gohor Plain
Mt Askoli
Mt Gaddaelo
Gwia
Plain
Falal
Plain
Datoma Alidas Plain
Desert
Mt Daneli
Mt Wasil
9°30'
Grassy plain
Gaburo
Daoe
Budaia
Erifible
Mofa (4500)
(Markets)
Gore
Galla
Abuzamara
Mt Ardgera
Open scattered bush
Dalle Faghe
Tomb
Dulale
Mt Afodella
Barren
Dulale
Alizara
Buri Plain
Assassibabiforo
Hills
Mtawatabur
Barakala Faghe
Barren
Forest
Oro Faghe
Scattered cliff dwellings
Dry swamps
Crocodiles
Barbel
Scattered cliff dwellings
Atofon
Gawani
Assaimara
Sandstone cliffs
Madima
Grass
Rasdaza
Magu
Mt Ayelu
Lat 8°04 56"
Long 40°42 06"
Treeless grassy plain
Sandstone
Hot springs
Hippopotami and Crocodiles
Barren plain
Zebras
Gibdo zo
Mt Kurbili
Mt Matala
Mt Kurbili
Mt Galalu
Lava
Mt Rassa
Galalu Plain
Mt Dabeta
Grassy plain, scattered thorns
Zebras & abundant game
Forest
Kortumi
Assoba
Mt Bareita
Dunkuga
Milu
Barren
Trees & grass
Aizamale
Additule
Eligle
Sublale
Aerolazo
Hippopotami and Crocodiles
Debene
Ontulti Omar
Forest belt both sides of river
Abundant game
Mt Farsis
Sulphur
Mt Dofan
+923
Unte
Rapids
Very broken country
Aleaduga Plain
Dobbi Faghe
Mt Fulemo
4370
Mt Assabot
8180
Mt Dalesho

Route Traverse

from

South to North

through

D A N A K I L

by

L. M. Nesbitt

1928

Scale 1:750,000

5 0 5 10 15 20

Statute Miles

10°30'

10°

9°30'

Mt Ayelu

Mt Amoissa
Lat 10°04 12"
Long 40°50 04"

Mt Afdam
6720

Afdam

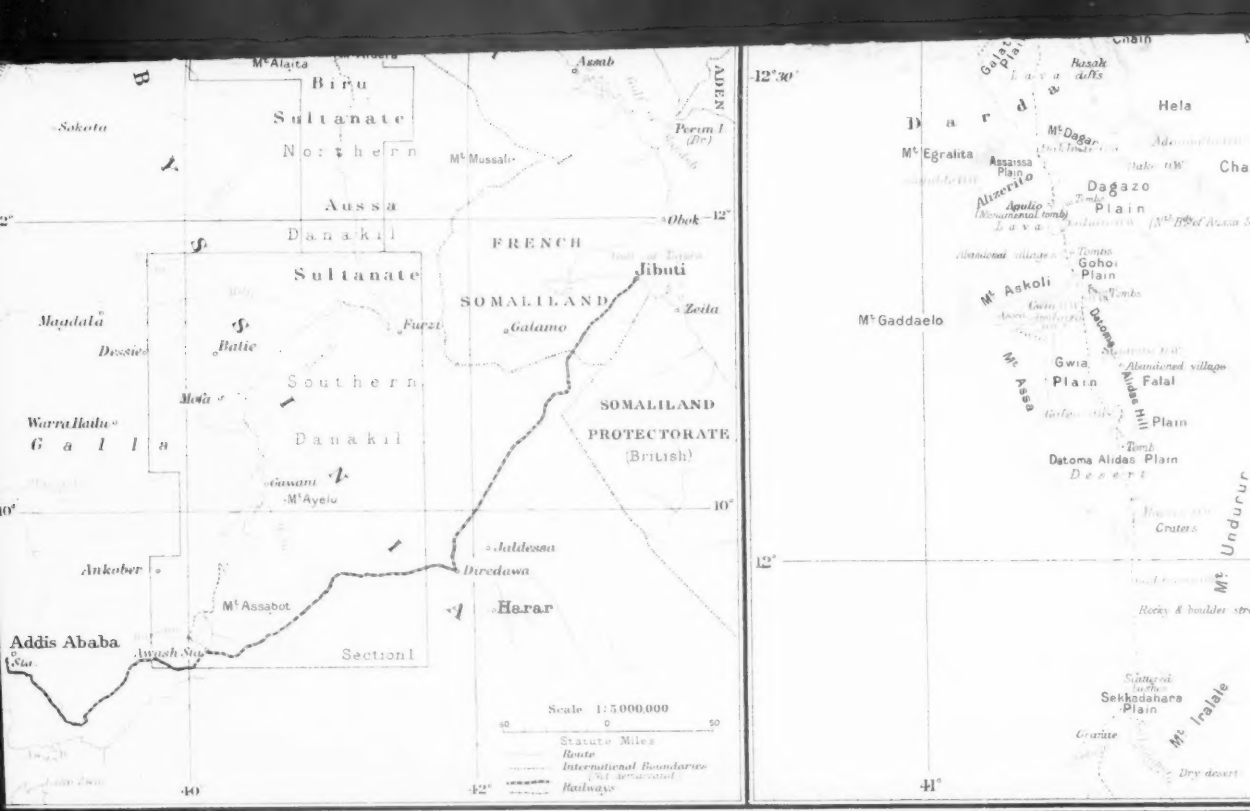
Railway to Ahitti

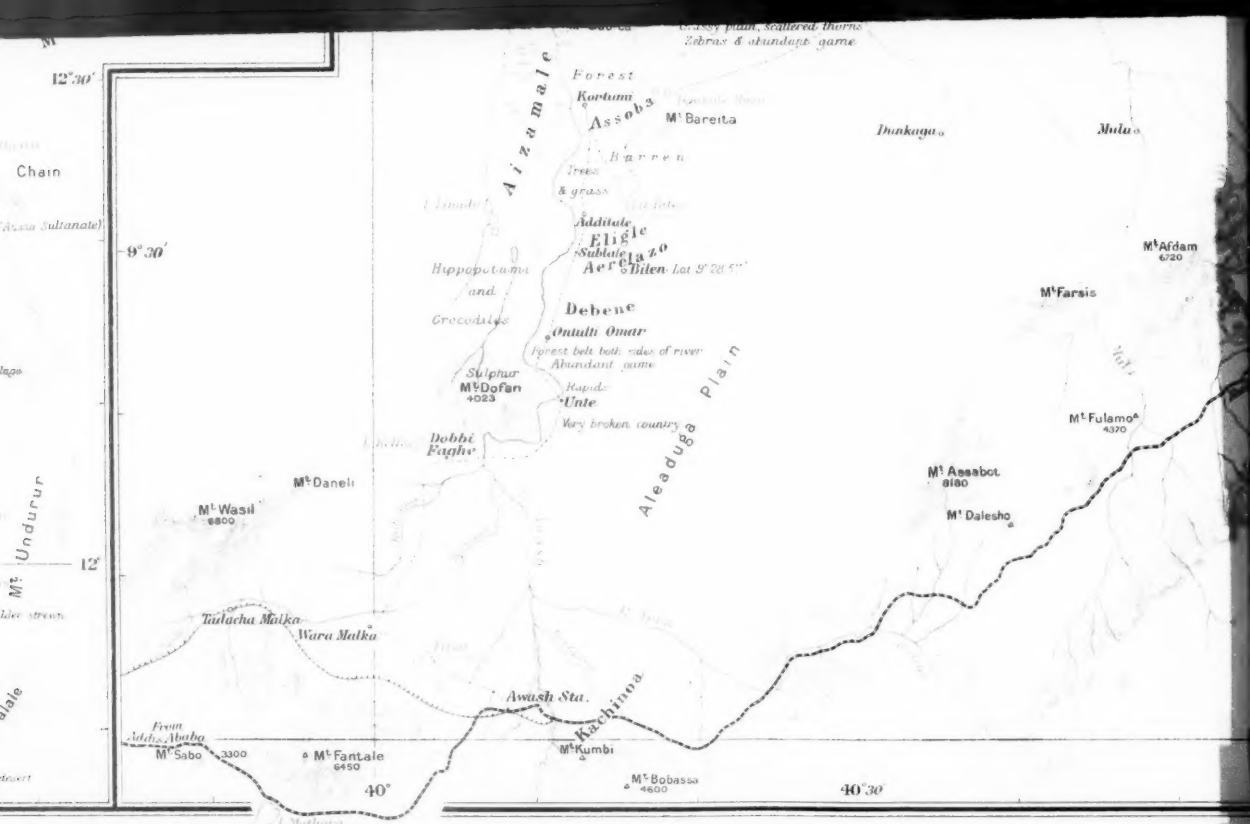
Mt Fulamo
4370

Reference

Route
Railway
Telegraph
Tribal names thus **Madima**
Waterhole
Permanent water
Occasional "
Mineralized

This map has been constructed from compass traverses and sketches of Mr Nesbitt (combined with the work of other explorers) adjusted to points fixed by the Harrison expedition 1899, Major C W Gwynn's triangulation 1908, and the positions of Dallol and Kululli which had been determined by officers of the Italian Navy in 1918. Heights are in feet, those in brackets being approximations


Mt Alaita
Assab
Biru
Sultanate
Sokoto
Northern
Mt Mussalo
Perim I (Br)
ADEN
Aussa
Obok
Danakil
FRENCH
Sultanate
Jibuti
SOMALILAND
Zeila
Furzu
Galamo
Magdala
Dessie
Batie
Southern
Mola
SOMALILAND
PROTECTORATE
(British)
Warra Hailu
G a l l a
Danakil
Gawani
Mt Ayelo
Jaldessa
Ankober
Diredawa
Mt Assabot
Harar
Addis Ababa
Awash Stn
Section I
Scale 1:5,000,000
Statute Miles
Route
International Boundaries
Railways
B
A
40
42°
12°
10°
Chalo
Basalt cliffs
Hela
Mt Dagar
Mt Egralita
Assaissa Plain
Dagazo Plain
Mt Askoli
Gohor Plain
Mt Gaddaelo
Datoma
Gwia Plain
Alidas Hill
Falal Plain
Mt Assa
Datoma Alidas Plain
Desert
Craters
Undurur
Mt
Sekkadahara Plain
Mt Iralale
Dry desert
41°



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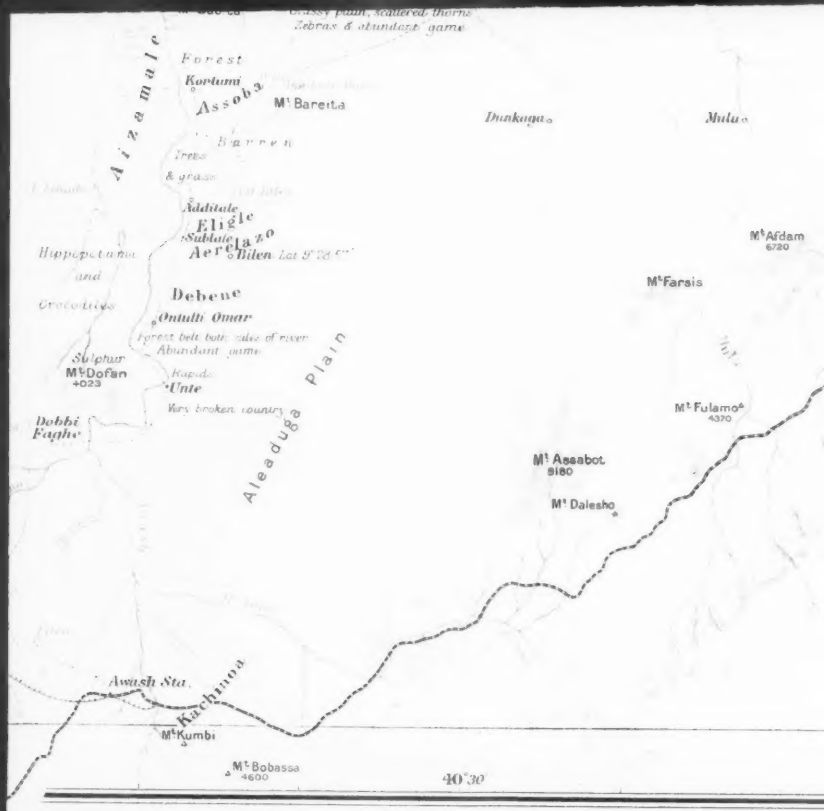

Geographical Society

Tribal names thus **Madima**

Waterhole
Permanent water
Occasional "
Mineralized

dam
ro

Midam

Railway to Addi

9°30′

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9°

41°

41°30′

ABYSSINIA

Nesbitt